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One Good Reason

• • • Among the reasons urged against federal financing of municipal works is that the works are not needed, that they will not pay their cost, and that credit can be obtained through normal channels if they are worthy of it. A specific case has put these arguments to a practical test.

• • • A village that plans to build needed waterworks on self-liquidating revenue bonds is ready to let contracts, which would put several hundred men to work. It has not been able to get the money, in spite of the large volume of public credit that has been extended to the banks. Inquiry of the Reconstruction Finance Corporation's agent showed him to be sympathetic. "We will loan up to 80 per cent on these bonds, but they must come to us through a bank." The banker, however, was hardboiled. "Not interested in using R.F.C.," he said.

• • • In a sense the banker is right. To get R.F.C. money he must stand back of the bonds, and he lacks confidence to do this. Moreover, every additional man out of a job further lessens his confidence. The R.F.C. can loan money, but it cannot loan confidence.

• • • Considering these conditions it is easy to see one good reason in favor of federal financing of local public works. It is the necessary start toward reconstruction by way of new employment and new confidence.

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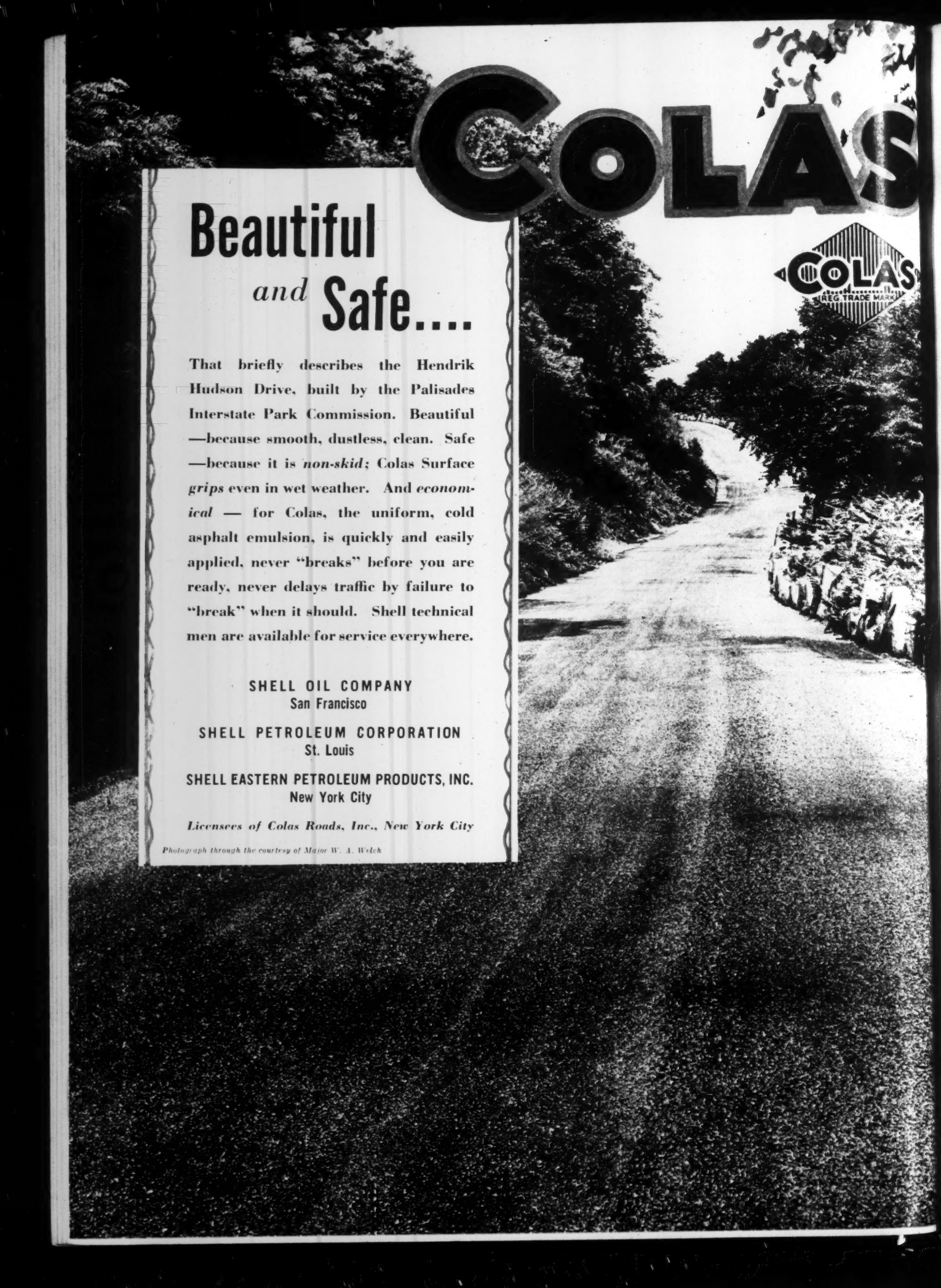

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F. E. Schmitt, Editor

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One Good Reason

AMONG the reasons urged against federal financing of municipal works is that the works are not needed, that they will not pay their cost, and that credit can be obtained through normal channels if the works are worthy of it. A specific case has put these arguments to a practical test. A village that plans to build needed waterworks against an issue of self-liquidating revenue bonds is ready to let contracts, which would put several hundred men to work. It has not been able to get the money, in spite of the large volume of public credit that has been extended to the banks. Inquiry of the Reconstruction Finance Corporation's agent showed him to be sympathetic: "We will loan up to 80 per cent on these bonds, but they must come to us through a bank." The banker, however, was hardboiled. "Not interested in using R.F.C. money," he said. In a sense the banker was right, for to get R.F.C. money he must stand back of the bonds, and he lacks confidence to do this. Thus the public money that has been poured into the banking system in order to revive the country's business life is left to stagnate because the financial mechanism devised to serve the needs of pioneer days now proves powerless to send that money out into the channels of use. These conditions reveal one good reason for federal financing of local public works. It is the necessary start toward reconstruction through new employment and new confidence.

✦ ✦ ✦

Beauty in Simplicity

BEAUTY in bridges as in other things is so much a matter of personal taste that it can hardly be fitted to any widely recognized yardstick. The most beautiful bridge selected by one group of critics may be unattractive or, at most, merely pleasing to many other persons. For this reason no final weight can attach to any one selection of the most beautiful steel bridges, such as the selection of three structures opened to traffic in 1931, as noted in our news pages. Yet one noteworthy inference may be drawn from the choice of the official jury. Taking the three structures as examples of good bridge architecture, it appears that simplicity is an important characteristic of such architecture. Decorative embellishment is notable for its absence. The Bayonne arch bridge, the Waldo-Hancock suspension bridge, and even more so the graceful little deck arch at West Stewartstown, impress the beholder with their structural honesty and simplicity. It is gratifying that this is so and that a competent jury recognized these qualities as true beauty, for, if bridge architecture for the most part has escaped the shifting tides of fancy that have periodically engulfed building architecture to its detriment, the result is mainly due to adherence to the tenets of simplicity. The design of more beautiful bridges is a worthy ideal, and precedent shows the way to its attainment, if careful attention to simplicity is maintained.

Work Is Cheaper

AMONG the self-appointed prophets who have been vociferous of late with claims of how they can help the taxpayer, there are those who assert that it is cheaper to dispense charity to the idle than put them to work. What they say not only is unworthy but it is untrue. H. P. Eddy brings its untruth out with a telling story from a fair-sized New England city, which shows that useful construction work costs the taxpayer less than a relief appropriation. The money relations in the case he cites are obviously basic and apply equally in every other community, if the accounting is properly done. Work is cheaper than a dole, in short, and Mr. Eddy performs a useful service in demonstrating this by figures.

Organization and Drive

SUCCESS in carrying through with unexampled speed the greatest group of tunneling operations ever undertaken, the driving of the four 56-ft. diversion tunnels at Hoover Dam, is attributable wholly to the power of organization and drive. The concentrated bulk of the work is represented by the fact that here, in a length of less than a mile, as much rock had to be broken and removed—a million and a half cubic yards—as in driving the world's longest railroad and water tunnels. In little more than a year this gigantic task was carried through, yet not a single essentially new method or piece of equipment was used. Skilful application of known methods and ingenious plant arrangement, backed by a remarkable degree of coordination and energy, accomplished the results against the tremendous handicaps of inaccessible location and oppressive climatic conditions. The account of the technical methods given in this issue is worthy of study as a record of the practices that furnished a landmark in tunneling history.

Carrying Water Over Mountains

SOUTHERN CALIFORNIA'S vital dependence on water and its ever-growing consumption place upon its engineers the responsibility of projecting their planning farther into the future than is required elsewhere. Vision and imagination are called upon to an exceptional degree. The great aqueduct described in this issue is an embodiment of these qualities. No city has ever gone so far for water as is now proposed by the thirteen cities and towns making up the Metropolitan Water District of Southern California, and the aqueduct 240 miles long across the mountains between the Coast and the Colorado is without parallel. In this growing need

for water also may be found part of the reason for California's active support of the Boulder Dam project, for the dam will provide most of the power required to pump the water through 1,600 ft. of height in crossing the divide. The bold planning that was begun eight years ago is nearing practical realization. Last fall the $220,000,000 bond issue was approved by the voters of the district, but only now the last obstacle is overcome by validation of the bonds by the state supreme court, and the work is ready to go forward. In measurable time Southern California will be carrying Colorado River water across the mountains.

Plain Speaking

SOUND advice was given to the electric power industry by Floyd L. Carlisle, chairman of the board of the Niagara-Hudson Power Corporation, at the convention of the National Electric Light Association in Atlantic City last week. "Our corporations are creatures of the various state governments," he said, "and are chartered to generate and distribute electricity at reasonable rates. That is the formula for the management of our corporations to follow. Efforts to evade or circumvent that formula are fundamentally dishonest, not to say stupid and asinine, and furthermore such efforts are wholly bad business. Such public criticism against the industry as is deserved and merited has very largely had its origin in efforts made within the industry itself to avoid that formula. Under the guise of management and supervision of contracts, efforts have been made here and there to charge operating companies with unreasonable and improper costs. In my judgment it is the duty of this association to take an active stand in stamping out such practices."

That statement should be printed in large type and pasted on the desk pad of every utility executive throughout the country and of the financial advisers who, in large part, are responsible for the pyramiding of companies to the profit of a few, in the days immediately preceding the beginning of the present depression.

Our privately operated public utilities should be among the most stable of our industries. They should have gone through this period of depression without such disruption as we now have before us in the case of the Insull properties. But the voices raised in protest against the methods followed in the boom days were raised in vain. Those who protested were looked upon as radicals to be scorned and ignored. The power companies were declared to be *private* corporations, not creatures of the state that created them, and anyone who questioned what they did was looked upon as a meddler with private business. Now the light is dawning. Some leaders at least are beginning to recognize that power companies are public utilities vested with certain rights not possessed by private companies because of the essential nature of their service, but subject to close control and scrutiny of their operations in return for the rights granted to them.

As between public and private operation of service utilities, the great majority of the people of this country favors private operation as being inherently more efficient. But with the spectacle before them of millions of dollars lost in the collapse of large utility systems, to say nothing of the millions yet to be written off as the result of other holding-company and corporate operations in the boom period, it daily becomes more difficult to convince the public that private operation of public utilities really is more efficient than public operation. Much money would have to be lost in publicly operated utilities to offset the losses to private investors during the past few months.

Mr. Carlisle's warning to the electric power industry therefore comes at an opportune time. The industry needed that kind of plain speaking. In concluding his remarks Mr. Carlisle said: "There is a great work that we can perform, which will be truly for the public welfare. This is the proper forum for the exchange of the most exact and scientific knowledge concerning our business. Our statistics, compiled from no other standpoint than the exact truth, can be helpful to government, to industry, to banks and to investors as well as to ourselves. I believe, furthermore, that we must enforce the highest ethical and business practices within our membership. I repeat that the purpose of this industry is the generation and sale of electricity at fair and reasonable rates and no other, and that any company violating that purpose should not be permitted to remain within this association." If the electric power and light industry goes forward adhering to those principles, it need not fear what the future may hold in store.

A False Step

RECENT action by the Associated General Contractors to set up a bureau for rating surety-bond companies should receive very careful thought by the membership of the organization. The action suggests pique and seems likely to bring confusion into a situation that was becoming well ordered. Nothing is promised by the new agency that cannot be better accomplished by the Bureau of Contract Information, a successful going concern in whose creation the Associated General Contractors participated actively and wisely.

Contractors and surety companies, working in harmony to establish the present Bureau of Contract Information, succeeded in making it one of the strongest forces now available to stabilize contracting. It has strengthened the standing of organized contracting with all the interests that deal with contractors. These are accomplishments that the contracting fraternity cannot afford to cast aside.

The new movement of the Associated General Contractors seems to be based on the view that the Bureau of Contract Information serves the surety companies alone, and on a desire to strike back by organizing a counter-service for contractors. The mutuality of action that built up the valuable record of contracting performance now possessed by the Bureau of Contract Information is forgotten or ignored, as is also the fact that the usefulness of this record extends far beyond service to bond underwriters and actually reaches every element of the construction industry.

If the function of the present bureau in providing information on the performance of contractors is not sufficiently mutual but requires supplementing by information on surety performance, this supplementary service should be created by further co-operative action. Attempts to provide the surety information by *ex parte* procedure can lead only to strife. The action taken represents a false step, therefore, and in the interests of construction industry progress it should be reconsidered.

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A Great Job Looms in the Colorado River Aqueduct

By F. E. Weymouth

General Manager and Chief Engineer, The Metropolitan Water District of Southern California, Los Angeles, Calif.

WITH THE DECISION on June 2 of the supreme court of California that bonds to the amount of $220,000,000, voted for the construction of the Colorado River aqueduct, are valid, work on that great water-supply project can begin, following the sale of the first block of bonds. The court's decision becomes final thirty days after its publication. The aqueduct will bring Colorado River water over the highlands lying between the Colorado River valley and the Los Angeles basin, a distance of 240 miles, to supply the thirteen cities making up the Metropolitan Water District of Southern California. Power for pumping the water will come, in large part, from Hoover Dam. —Editor.

THE THIRTEEN cities composing the Metropolitan Water District of southern California, on Sept. 29, 1931, by a vote of practically 5 to 1, authorized a bond issue of $220,000,000 to finance the building of an aqueduct to supply the Los Angeles metropolitan area with water from the Colorado River. In November a taxpayers' suit was begun in the superior court of Los Angeles County to invalidate the proposed bond issue. The court upheld the validity of the bonds and of the election at which they were approved. Subsequently appeal was taken to the state supreme court. The decision of that court, which was rendered on June 2 last, upholding the result of this election, removes definitely the menace of water shortage in southern California and strengthens and extends the financial foundation of the remarkable development that has taken place in this semi-arid region during the past three or four decades.

As constituted at present, the district comprises the thirteen cities of Anaheim, Beverly Hills, Burbank, Compton, Fullerton, Glendale, Long Beach, Los Angeles, Pasadena, San Marino, Santa Ana, Santa Monica and Torrance, with a combined population of 1,666,000 and an assessed valuation of $2,400,000,000. Applications for admission are now pending from a number of other cities of the southern California coastal plain.

The project will include a main aqueduct 240.5 miles long to bring the water over the high areas between the Colorado River and the basin surrounding the city of Los Angeles, storage facilities for regulating the flow to meet fluctuations in demand, and distribution lines for delivering the water at wholesale into the existing water-supply systems of the cities composing the district. The total static pumping lift will be 1,583 ft. Power for pumping will be secured principally from the government plant at Hoover Dam, but some power will be generated at the intake and at drops within the distribution system. The general location of the project is shown on Fig. 3.

Plans call for the ultimate diversion from the river of an average flow of 1,500 sec.-ft. The main aqueduct is to be built to full capacity at the start, except in the case of multiple-unit features, such as steel pipes, pumping machinery, etc., portions of which may be deferred without greatly increasing the ultimate cost. Local facilities, such as storage reservoirs and wholesale delivery lines, are to be built to about one-half capacity at present and later enlarged as the demand for water increases.

The diversion

Water is to be taken from the river at a point about 18 miles upstream from Parker, Ariz., where the flow is confined in a narrow rock canyon. The diversion can be made by pumping directly from the river without a dam, but present plans contemplate the construction of a diversion dam as a part of the first development. As released

Fig. 1—The site chosen for the Parker Dam is in the narrow rock canyon, about the center of the picture, below the mouth of the Bill Williams River, which comes in from the foreground. Beyond are the mountains over which the aqueduct goes.

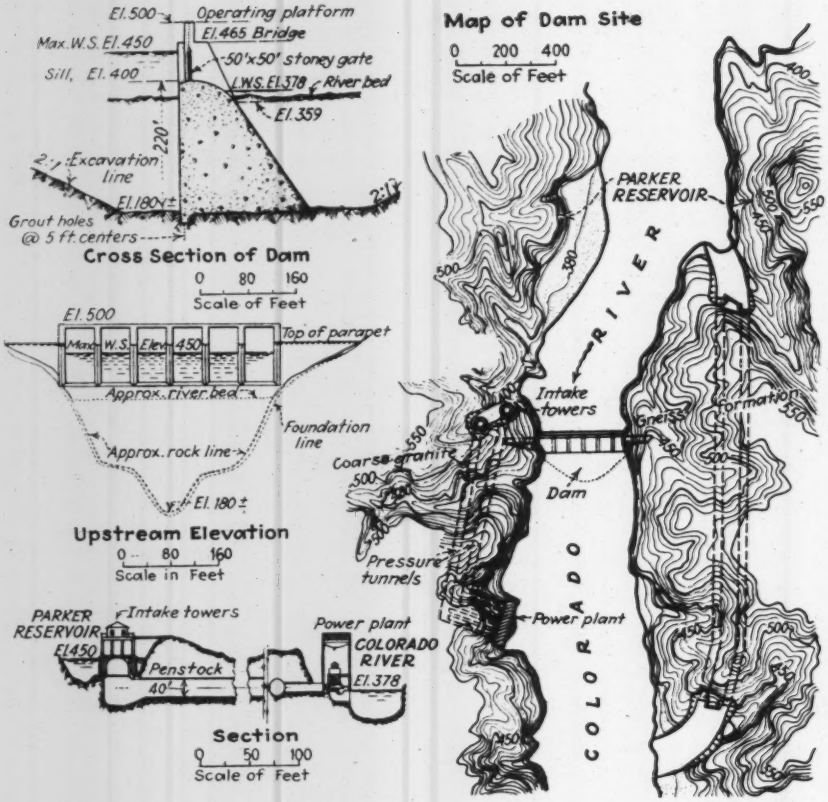


Fig. 2—Parker Reservoir will be formed by a dam raising the water level a maximum of only 72 ft. but extending nearly 200 ft. below the river to a firm foundation.

from the reservoir back of Hoover Dam, the water will be clear; but until a new regimen is established in the river a fresh load of silt will be accumulated before the diversion site is reached.

The diversion dam will raise the water surface 72 ft., creating a reservoir of 716,000 acre-ft. capacity. This will again clarify the flow of the river, stabilize diversion conditions and reduce the required pump lift. It also affords opportunity for the development of 80,000 kw. (maximum) of electrical energy. The general appearance of the dam site is shown in Fig. 1. A cross-section of the river, as established by borings, and a preliminary section of the dam are shown in Fig. 2.

Geological conditions at the dam site are simple. The rock on both sides of the river and beneath the riverbed is coarse granitic gneiss, which is only slightly weathered and is generally of massive character, with only moderate jointing. The rock throughout is of excellent character for a dam foundation. The overburden, consisting of silt, sand and gravel, has a maximum depth of 190 ft. Excavation at the site will not be undertaken until after the river is under control at Hoover Dam, and no particular difficulties are anticipated.

The dam is to be designed to pass a flood of 480,000 sec.-ft. without overtopping the crest. This is a somewhat more liberal provision than that contemplated at Hoover Dam, but it is desirable in order to care for the remote contingency of a flood from the Bill Williams River superimposed upon an upper-river flood. Floods will be passed directly over the spillway section of the dam and controlled by some type of movable crest.

The main aqueduct

The main aqueduct is being designed for an average flow of 1,500 sec.-ft., with an allowance of 7 per cent for loss of time due to interruptions, resulting in a peak capacity of 1,605 sec.-ft. The intake is to be located some distance upstream from the dam site, from which point the water will be raised 591 ft. in two approximately equal stages, first into Gene Wash Reservoir and then into Copper Basin. The first 12 miles from the intake is in rough country and consists of a series of short tunnels, siphons and surface conduit sections, broken by the two reservoirs just mentioned. This is followed by 100 miles of unusually favorable location across a desolate uninhabited region, where the line is largely in open canal, with occasional siphons and tunnels.

Reaching the head of the Chuckwalla Valley at Mile 112, the line climbs by three pump lifts across the hills, skirting the northeast rim of Imperial Valley and passing into the drainage basin of the Salton Sea. The first two of these lifts, which may be combined into one as a result of studies not yet completed.

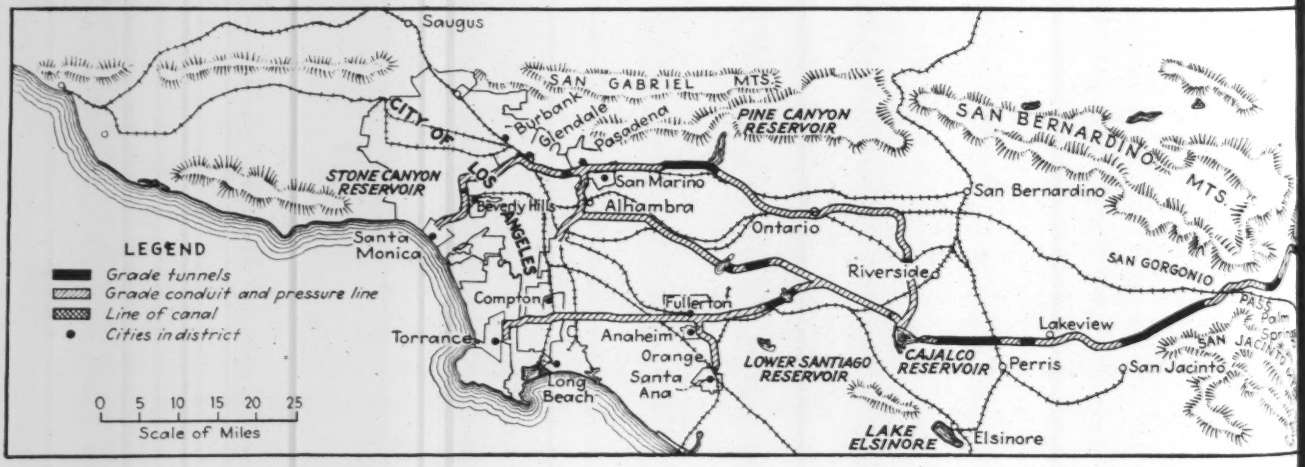
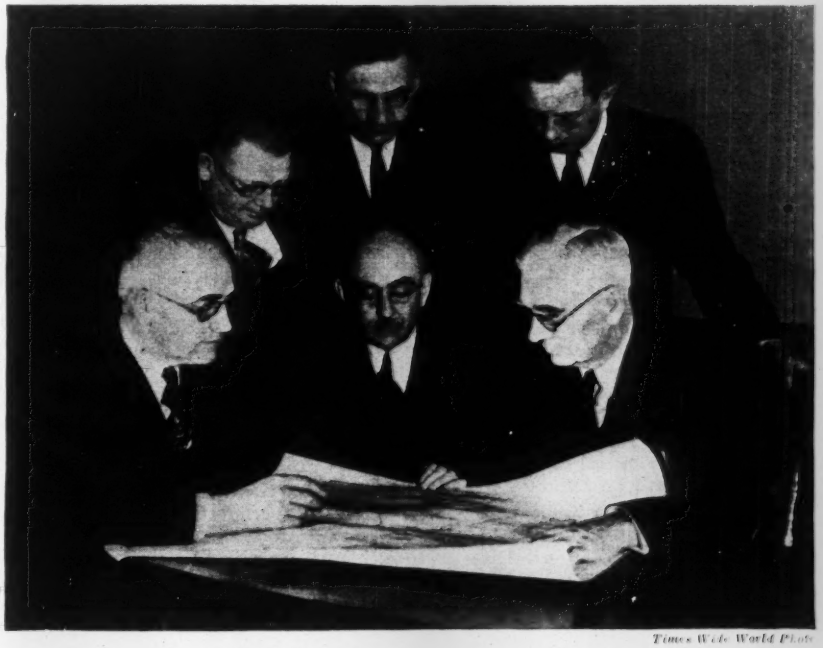


Fig. 3—The main aqueduct to bring Colorado River water to the towns making up the Metropolitan Water District of Southern California extends from near Parker on the eastern side of the state to a terminal reservoir on the Pacific slope, a distance of 240 miles. From the Cajalco reservoir, distributing lines will serve the cities of the district. Final location of the aqueduct and distributing lines may vary somewhat from those here shown.

deliver the water into Hayfield Dry Lake, where, at nominal cost, an equalizing and reserve storage reservoir of 86,000 acre-ft. capacity can be developed. The third lift of this group raises the water 460 ft. from Hayfield Reservoir to an elevation, whence by tunnel and conduit it is carried across Shavers Summit and along the rim of Coachella Valley. Rounding the eastern end of the Little San Bernardino Mountains, the aqueduct traverses in tunnel, siphon and cut-and-cover conduit the rough and broken country along their lower slopes, reaching the head of the valley at about Mile 190.

Here the line approaches the San Andreas fault, which intersects every feasible route from the Colorado River to the Los Angeles area. On this route the fault is crossed squarely and on the surface, affording minimum opportunity for damage and interruption of service in case of earth movement. Avoiding the broken material underlying San Gorgonio Pass, a shorter and more direct line pierces the solid granite of the San Jacinto Mountains with a 12.7-mile tunnel, emerging on their western slopes to cross the active San Jacinto fault at the ground surface and proceed in siphon, surface line and tunnel to the terminal reservoirs. The composition of the main aqueduct is as follows:

Tunnel 84.88 miles; cut-and-cover conduit, 54.58 miles; lined canal, 75.04 miles; concrete pipe lines, 24.52 miles; through reservoirs, 1.5 miles; total length, 240.52 miles. Total pump lift is 1,583 ft.; mean diversion capacity, 1,500 sec.-ft.; peak diversion capacity, 1,605 sec.-ft.



Times Wide World Photo

Fig. 5—Major questions as to the aqueduct are put up to members of the engineering board of review. The board is here shown in consultation with the district's engineers. Left to right: Frank E. Weymouth, general manager and chief engineer of the water district; R. W. Sorenson, electrical engineer; Thaddeus Merriman, chief engineer, board of water supply, New York; Richard R. Lyman (above) consulting engineer, Salt Lake City; Harvey S. Mudd, mining engineer; and Arthur P. Davis, consulting engineer, Oakland.

Terminal storage

The main aqueduct will end in either Cajalco, Valverde or Mocking Bird Canyon, in each of which suitable terminal reservoir basins, with excellent foundations for any type of dam, are available. Besides these, several smaller reservoirs are contemplated along the distribution lines, nearer the points of consumption. Storage in these smaller

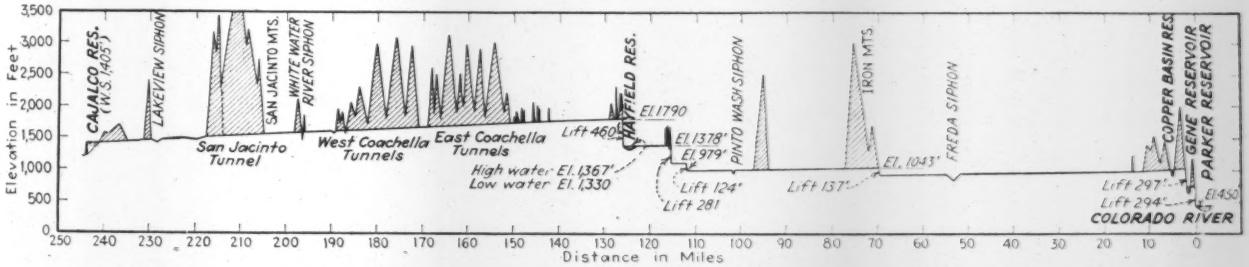
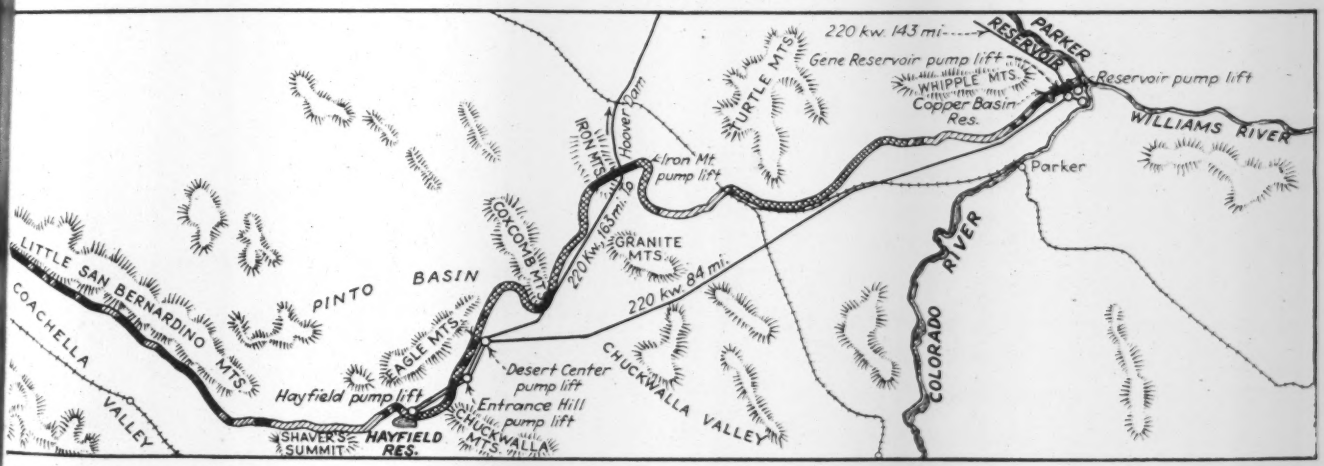


Fig. 4—Pumping will be required at several points along the aqueduct. Most of the power will come from Hoover Dam.



reservoirs will reduce the required peak capacity in the delivery lines, aid in the manipulation of water for power generation and increase the safety by division of storage.

Present plans contemplate an ultimate terminal storage capacity of 250,000 to 300,000 acre-ft. This will regulate the flow and provide a 60-day emergency supply. Of this amount 100,000 acre-ft. will be built now, leaving the remainder to be added as required. Unlimited seasonal storage is available in the Hoover Dam reservoir, local emergency storage being required only as a protection against an interruption of aqueduct flow.

Wholesale delivery lines

The general location of the feeder lines is shown in Fig. 3. The northern line will have an initial capacity of 510 sec.-ft., which will be sufficient to meet

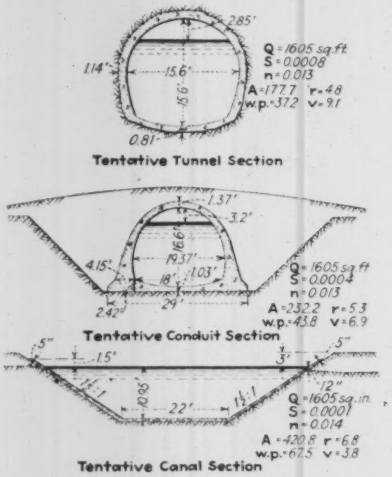


Fig. 6—The aqueduct will be made up chiefly of open canal, closed conduit or tunnel of sections shown here.

the ultimate needs of the higher areas to be served with Colorado River water. It will therefore have excess capacity at first. This excess capacity will be utilized temporarily to supply certain areas at intermediate levels, thus avoiding a separate line for these areas for the present. This line may utilize the Pine Canyon Reservoir in San Gabriel Canyon, contract for which has been let.

The initial construction will also include a low line of some 320 sec.-ft. capacity direct to Long Beach and the harbor district, supplying also the Orange County area. This line is to be controlled by a reservoir in San Juan Canyon. The area served by this line is at a relatively low elevation, and a power drop of 330 ft. is possible near the head of the line. For ultimate development, an intermediate line will be required, to relieve the draft on the high line and to supplement to some degree the low line deliveries. The prospective locations of these future lines are shown on Fig. 3.

Although plans for the distribution

Fig. 7—Thaddeus Merriman, consultant, and J. B. Bond, construction engineer of the district, getting first-hand information as to rock formations along the line of the aqueduct.

system have been worked out with great care, they are nevertheless to a certain extent tentative, as the ultimate composition of the district is not yet known. Also, before the plans become final they will be discussed in further detail with the waterworks officials of the various cities and adjusted, as far as possible, to meet all local needs.

Present status of work

Active prosecution of construction work has not been possible pending validation by the state supreme court of the district bond issue. This has now been accomplished by a unanimous decision of the court announced June 2, 1932, which decision, however, does not become final until 30 days after that date. As soon thereafter as funds are assured, calls will be issued for bids on several of the longer tunnels and other construction features. Until money thus becomes available no enlargement of the existing engineering organization or construction forces is planned.

On account of the present unemployment situation, men are now available in southern California in excess of all requirements for every opening that the aqueduct work can possibly afford for months to come, and in the hope of avoiding the otherwise inevitable disappointment and possible suffering awaiting newcomers and their families the board of directors last fall announced the policy, effective until conditions have materially improved, of permitting the employment in the district organization or by contractors on district work of none but those who have resided within the district for at least one year. W. P. Whitsett is chairman of the board of directors of the district, and the author is general manager and chief engineer. Julian Hinds is chief designing engineer.

Long Cantilevers in Trinity River Crossings at Dallas

CONSTRUCTION of the Trinity River levees at Dallas, Tex., required four major bridge structures over the floodway at Lamar, Commerce, Cadiz and Clarence Sts. The view shows a portion of the Lamar St. viaduct, which is about 2,000 ft. long and typical of the other structures. The particular element of interest in the bridges centers on the steel channel spans, which are haunched-cantilever girders 200 ft. long over all, made up of two 40-ft. anchor arms and a 120-ft. main span. In addition to their unusual length, these channel spans are given the same concrete fascia finish as the flanking concrete spans, thus providing an appearance of continuity for the bridge as a whole. F. D. Hughes, consulting engineer, Dallas, Tex., designed the viaducts, the total cost of which was about $1,865,000. Because of many duplications of spans and piers the cost per square foot of all the structures was very low, about $3.60 per square foot, including lighting and paving. The total bids were about 27 per cent under the estimated cost.

Typical new viaduct in Dallas, Tex., which crosses newly created floodway for Trinity River.

Thick Concrete Slab Acts Well Under Locomotive Test Load

Unique test of a 2½-ft.-thick slab indicates good lateral distribution of load within slab and no serious effect from impact

By C. V. Armour
Consulting Engineer, Toronto, Ontario

TESTS of a reinforced-concrete railway bridge slab 2½ ft. thick, spanning a main thoroughfare in London, Ontario, and carrying the Canadian National Railway tracks, have provided some results that are unique and significant, since these tests are believed to be the first in which a modern engine and tender have been used as the loading element. The lateral distribution of load throughout the slab was found to be surprisingly good,

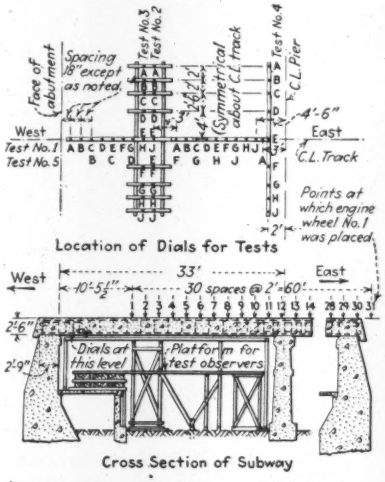


Fig. 1—Test layout for measuring-deflection on a 2½-ft. thick concrete-slab railroad deck under heavy locomotive loading.

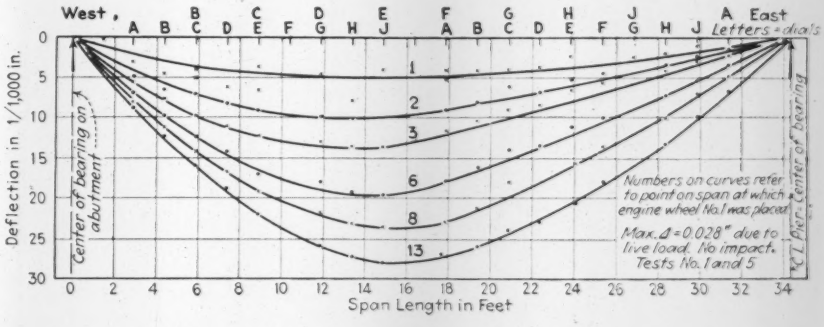
and impact effect was negligible so far as stress increase was concerned, although appreciable vibrations were observed on the test dials.

The tests were planned with the fact in mind that the use of reinforced-concrete slabs in grade-separation structures is increasing and that it is necessary to keep these slabs as shallow as possible and to know something of the behavior of such slabs under actual load. The test set-up is shown in Fig. 1. A portion of the slab 2 ft. 6 in. deep and continuous over a center pier was loaded by means of an engine and tender of the latest design, running over rails supported on standard timber track ties. The slab, reinforced for tension and compression, showed concrete cylinder strengths of 3,220 and 3,460 lb. per sq.in. at 28 days. Deflections were recorded by means of nine Ames dials graduated to 1/1,000 in., mounted on firm bases and placed as indicated in Fig. 1. Particular care was taken to keep the observer's platforms separate from the staging supporting the dials and to give this staging a firm foundation.

Maximum deflection

In making the tests the engine was brought to a stop with its No. 1 wheel over point No. 1 on the slab and a set of readings taken on the dials. The No. 1 wheel was then advanced to point No. 2 and readings were taken. This procedure was repeated until point 13 was reached, when the train was backed off while the instruments were set in their new positions for a second series of readings. In Fig. 2 the curves are given for six of these sets of readings, and it will be noted that the maximum deflection (0.028 in.), if based on span length, equals 0.028 ÷ 412.8, or 0.000067.

Fig. 2—Deflection curve along center line of track. Numbers on curve refer to point on slab at which engine wheel No. 1 was placed. A maximum deflection of 0.028 in., due to live loads with no impact, was observed.


West
East
Letters = dials
Deflection in 1/1,000 in.
Center of bearing on abutment
C.L. Pier Center of bearing
Numbers on curves refer to point on span at which engine wheel No.1 was placed
Max. Δ = 0.028" due to live load. No impact. Tests No. 1 and 5
Span Length in Feet

Lateral distribution

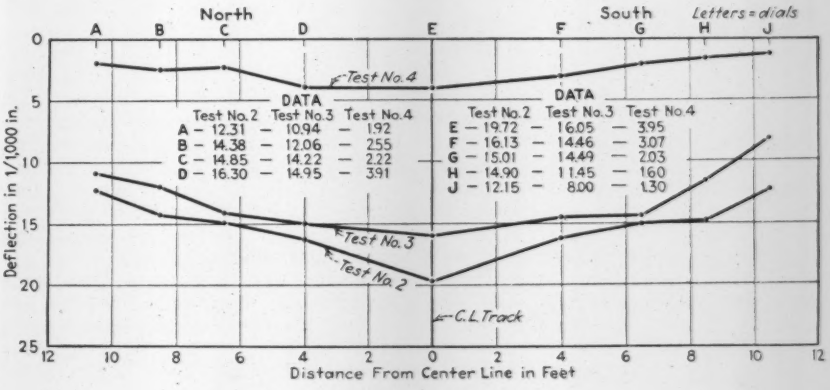
In studying the lateral distribution of loads in the slab, dials placed at right angles to the track were utilized. Three tests were run (Nos. 2, 3 and 4) in which one test (No. 3) was made with the dials at the point of maximum deflection. In Fig. 3 are given curves averaging the results of the three tests. Noting that point E, designated as 0 on the scale of feet, represents the center of the tie, the lateral distribution of the load in the slab may be traced. Since, within the working limits of the materials, the stresses are proportional to the deflections, stress values may be computed in percentages of the deflection (stress) at the center of the tie or track, this latter stress being assigned a value of 100 per cent. The accompanying table gives such a distribution of load at the point of maximum deflection or critical stress.

It is common practice in railroad designing to distribute the load uniformly over a 13-ft. width of slab. From the above table the average stress in this

LATERAL STRESS DISTRIBUTION IN SLAB
(Stress on Center Line Is 100 Per Cent)

North of Center Line of Track, Per Cent	South of Center Line of Track, Per Cent	Distance North or South of Center Line of Track, Ft.
97.9	97.7	1
95.4	94.9	2
93.0	92.0	3
90.3	88.6	4
88.3	88.2	5
86.4	87.6	6
85.2	86.9	6½
82.6	84.3	7
78.6	78.6	8
72.7	71.3	9
68.2	61.9	10
65.8	56.8	10½

Fig. 3—Lateral distribution of load throughout slab is shown by average curves for three test series.


North
South
Letters = dials
Test No.4
Test No.3
Test No.2
C.L. Track
DATA
Test No.2 Test No.3 Test No.4
A – 12.31 – 10.94 – 1.92
B – 14.38 – 12.06 – 2.55
C – 14.85 – 14.22 – 2.22
D – 16.30 – 14.95 – 3.91
DATA
Test No.2 Test No.3 Test No.4
E – 19.72 – 16.05 – 3.95
F – 16.13 – 14.46 – 3.07
G – 15.01 – 14.49 – 2.03
H – 14.90 – 11.45 – 1.60
J – 12.15 – 8.00 – 1.30
Deflection in 1/1,000 in.
Distance From Center Line in Feet

width is 100 per cent plus 86.05 per cent divided by 2, or 93.02 per cent. It is often impossible to use a wider distribution, since the tracks are usually spaced 13 ft. apart; but, where it is possible, a greater distribution seems permissible and economical. For example, if a 16-ft. strip is used, the average stress would be 89.3 per cent. The loads, when reduced to a uniform distribution, would be divided by 16 instead of 13 ft. Since, for a rectangular beam, $wl^2/c = Rbd^2$, d varies as the square root of w for any one class of concrete in which the working stresses, width of strip and length of span are kept constant. Consequently, w now being only 13/16 (81.25 per cent) of the former load, we save 18.75 per cent in w and consequently the square root of 18.75 per cent, or 4.33 per cent in depth. The above table may also be used to indicate the distribution of load to the substructure.

In order to observe the effect of impact, the train was run at various speeds and the brakes were applied in some tests. After each test, while the train was backed slowly off the slab, the dials were observed to read about the same maximum deflection as during the speed test. From the results it was concluded that no greater deflection was produced than in the tests with stationary loads. Consequently, it would seem reasonable to say that there is no appreciable effect from impact on this type of slab. It was observed, however, that the dial needles flickered to their maximum positions, indicating appreciable vibration in the slab. These tests are by no means exhaustive but indicate results that warrant serious consideration. At the least, for this type of construction, they show that there are no excessive vibrations to impair its durability, and they raise a question concerning the justification of the usual allowance for impact.

Rio de Janeiro Sewered by Private Company

Flat rate charged for use of sewers and sewage treatment in capital of Brazil

RIO DE JANEIRO, the federal capital of Brazil, is perhaps the largest city in the world in which the sewerage system is owned and operated by a private company. The owner is the Rio de Janeiro City Improvements Co., Ltd., a British joint stock company founded in 1862, which holds an exclusive "concession" or franchise. With the exception of the city of Rosario de Santa Fe, in the Argentine, this sewerage system is believed to be the only privately owned one on the east side of South America.

The original sewerage system was designed by Gotto & Beesley, consulting engineers, London, and was constructed by contractors under their supervision. For many years all extensions of the system have been carried out by the company.

Up to 1912 the sewerage was on the partly combined system; since then houses have been sewered on the absolutely separate system. The number of houses connected with the sewerage system increased from 14,602 in 1862 to 92,344 on March 31, 1932. A storm-water system is owned and operated by the municipality.

The sewage from six of the seven districts into which the city is divided is treated chemically with lime, alumino ferric and charcoal in continuous-flow tanks. The object of this treatment is to precipitate all floating solids and produce an effluent that can be safely discharged into the bay. The outlets are so distributed as to discharge the treated sewage at widely separated points. At one of the technical works in a populous district chlorine is applied to the effluent for the purpose of obviating any fly nuisance.

The sewage from the seventh zone, on the south side of the city, is pumped without treatment and discharged into the ocean some miles along the coast, the ocean end of the outfall sewer being 394 ft. long, 8 ft. in diameter, flattened to a height of 7½ ft. and discharging into water 13 ft. below the surface.

In 1911 the company constucted a sewerage and sewage disposal system on the Island of Paqueta, which is situated in the bay about 8 miles from the mainland. The disposal works consist of hydrolytic tanks, bacterial fllters and humus tanks.

Rio de Janeiro was one of the first cities in South America to attempt sewage treatment, despite the fact that the effluent is discharged into an enormous volume of tidal water. The original treatment stations were situated, when built, in isolated parts of the city, but due to rapid building development the plants are now surrounded by dwelling houses and other buildings.

During the past twenty years various schemes have been considered for extending the company sewerage system to serve all the outlying suburbs. Consideration has also been given to the construction of a new treatment plant located in the northern part of the city and the abandonment of the plants now scattered through the city. For the plant remaining in the southern part of the city, thought has been given to the construction of detention reservoirs on a peninsula just outside the bay, from which the sewage would be discharged at ebb tide.

The basic charge for the use of the company's sewerage system is a flat rate of $19.58 at the standard exchange rate for the pound of $4.865. This charge was originally levied on every property connected with the system, regardless of its size or number of sanitary appliances. As time has gone on, changes in the classes of buildings in use have made it necessary to modify the charge. Apartment houses and buildings used as flats are now each charged a third of the fixed rate named for every self-contained place of residence, provided it has no direct communication with any other flat or apartment in the same building. Aside from this, the old charge prevails and is the same for each unit served, whether a house, a hospital of a commercial building. All these larger units pay the same rate as the smallest dwelling house.

The volume of sewage treated at the six chemical precipitation plants during the year 1931 averaged 25,011,700 imperial gallons a day, or 30,039,051 United States standard gallons. In addition, there was delivered to the ocean, untreated, an average of 1,153,000 imperial, or 1,384,753 U. S., gallons.

British Engineering Standards Association Reorganizes

Recognizing the desirability of a single central standardized national body in each of the countries forming the British Empire, the British Engineering Standard Association has reorganized as the British Standards Institution. During recent years the association has prepared standard specifications and established standards not only for use in the British engineering field but also for a growing range of materials in the building, chemical and textile industries. Hereafter the work will be done by four main divisions of equal standing, responsible for the preparation of standard specifications in the engineering, chemical, building and textile industries, each of the divisions being under the control of a representative divisional council. The great development in the standardizing movement, which has taken place since the first committee was set up by the Institution of Civil Engineers in 1901 as the Engineering Standards Committee, is indicated by the fact that there are now 600 committees and 400 published standard specifications in existence.

Driving 56-Ft. Tunnels for Hoover Dam

Unique drilling carriages developed for enlarging operations—Rounds average 16 ft. and break 1,000 cu.yd. of rock—438,485 cu.yd. excavated in one month—No trouble experienced in trucking operations for removal of tunnel muck

A NEW CHAPTER has been written in the history of hard-rock tunnel driving. Discarding established methods as inapplicable to the magnitude of the work and the speed required, the Six Companies Inc. devised new equipment and developed new methods. Special problems were presented in attacking a face 56 ft. in diameter and advancing 75 per cent of this area in one operation. The successful solution of these problems has placed the Hoover Dam project ahead of schedule and will permit further acceleration of the work. To those interested in the carrying forward of the project the following article describes one of the major steps, and to those interested in tunneling it brings information of a distinct advance in the art. —EDITOR.

UNIQUE tunneling equipment and new methods of driving have enabled phenomenal progress in the four 56-ft. diversion tunnels that form the first major construction element of Hoover Dam. Confronted by unprecedented size of bore for the aggregate length of 16,000 ft., and the necessity of maintaining unusual speed in driving, the contractor broke away from established precedent. The removal of 438,485 cu.yd. of tunnel excavation in one month, the driving of 256 ft. of bench enlargement (1,844 sq.ft. of face) in eight headings in one day and the advance of one bench 246 ft. in 21 shifts., including the removal of 16,788 cu.yd. of rock, are typical of the results accomplished.

Program of attack

The entire plan of project development being dependent upon the completion of the diversion tunnels, it was essential to open up as many faces as possible with the least delay. It was decided that the most feasible plan was to drive a top center heading in advance. The 4,000-ft. length of each tunnel made feasible two extra faces for this center heading in each bore from an adit about mid-length on each side of the canyon. Fig. 1 is a sketch plan of the tunnels and adits. Each tunnel will have a 50-ft. finished diameter inside a 3-ft. concrete lining.

Work was under way on the adits within six weeks after the first of the construction force had arrived in the field. This work involved the transportation of supplies and equipment through the canyon by boat and barge, the blasting of a foothold on the canyon walls for compressor plant and equipment and the construction of a suspension bridge for a walkway and to carry air lines across the river. The two adits (10x8-ft.) were started with temporary equipment. Mucking machines and storage-battery locomotives were employed later when electric power became available. Intersecting the first diversion tunnel at 370 ft., the adits were continued until they reached the inside tunnel line 715 ft. in from the canyon wall. The opening of these eight faces was followed immediately by turning 12x12-ft. top headings.

In the meantime some work had been started in opening up the headings at the portals. This work was slower because it required the construction of roads to the lower portals and equipment for stripping the portal faces; most of the footage in the top headings was driven from the adits.

Three main compressor plants were established during this phase of the work and were subsequently enlarged, when work on the bench started, by the addition of more units. The capacity of all three plants is now 16,000 cu.ft.; the downstream portal plant with a capacity of 8,000 cu.ft., is the largest. These main compressor stations were located at the upstream portals, the adits and the downstream portals. The equipment consisted of standard compressor units of 1,000- and 2,000-ft. capacity drive by synchronous motors. The usual provision for air screening at the intake and water cooling were installed. From the plants the air is piped into the tunnels in 4- or 6-in. lines.

The 12x12-ft. top headings were driven by pulling rounds of about 12 ft. The drilling was done from rail-mounted drill carriages carrying either two horizontal bars or two columns that supported two drills each. The mucking was by machine, and transportation was by storage-battery locomotive and 3½-cu.yd. side-dump cars.

In addition to the primary purpose of opening up the tunnels for enlargement, the headings were of particular value in determining the character of rock and the way it would handle, as well as aids in ventilation during subsequent operations.

Bench enlargement

The enlargement of the tunnels from the 12x12-ft. heading to the final diameter of 56 ft., with the exception of a 14-ft. depth of invert section, which was excavated last, constituted the major driving operation. The method of handling this enlargement of a face 1,844 sq.ft. in area, the new equipment devised, the sequence of operations developed and the rate of progress maintained presented features of special interest.

At one portal the enlargement to full size was begun before the heading had been holed through from the adit, and a top heading or bench, arch-shaped and 12 ft. high, was carried forward one round ahead of the main bench. This was mainly an experiment, and the operation was changed to typical enlargement procedure as soon as the heading was completed. Some experiments were made in ring-drilling from the 12x12-ft. heading, but this method of enlargement did not prove satisfactory

Fig. 2—Drilling diagram for bench enlargement, wings and invert, showing firing sequence.

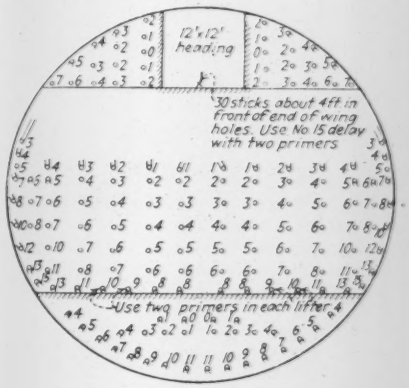
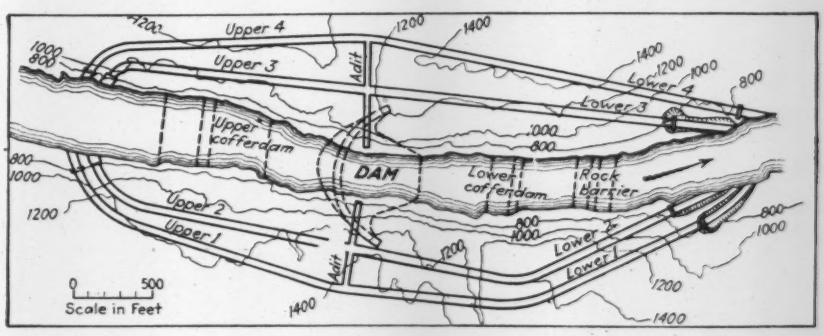

12'x12' heading
30 sticks about 4ft in front of end of wing holes. Use No 15 delay with two primers
Use two primers in each lifter

Fig. 1—Sketch plan of diversion tunnels in relation to river and dam site, showing locations of adits.



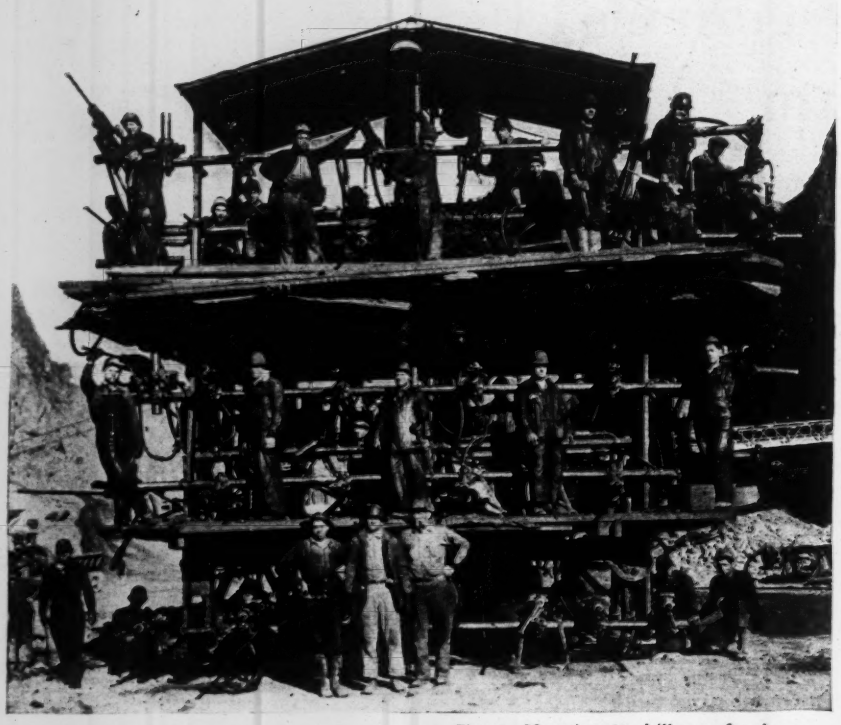


Fig. 3—Mounting 30 drills on five bars, this drilling carriage of welded structural steel is built on a motor-truck frame. This equipment drills, in two settings, the 110 holes for the main bench enlargement.

and was not continued. Practically all the enlargement was from the pioneer heading by carrying forward the main bench and the two small wing sections simultaneously.

The rock is hard, but it drilled very easily. With careful attention to location of drill holes and distribution of charges, it was broken to line very successfully, and, in addition, no trouble was experienced in reducing it to a size that could be handled by the shovels. Ability to keep close to section was of particular advantage because the size of tunnel would have made overbreak an extremely expensive item.

The rock is exceptionably free from faults and seams. It stands well without timbering, even in the 56-ft. excavation. The tunnels were dry, with the exception of a few small flows that were handled without delay to the work.

The wing sections on either side of the heading represented 270 sq.ft. of face and were carried forward at the same time, but about 25 ft. in advance of the main enlargement. Two columns carrying two machines each drilled these wing sections and were set up as soon as the muck had been pushed off the upper bench. Fifteen holes were drilled in each wing (Fig. 2). After being drilled and loaded, these wing sections were handled as part of the general cycle of operations, as is described later.

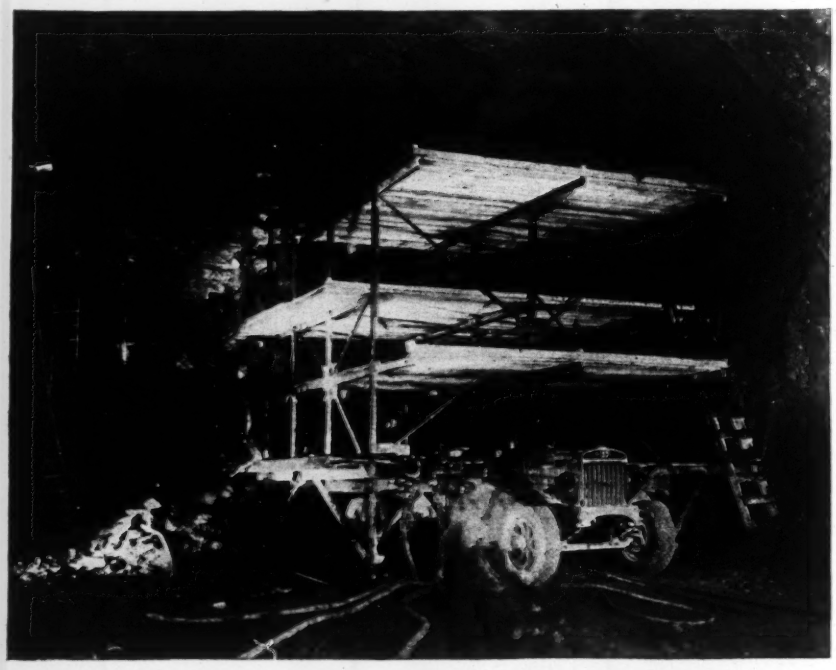
Drilling and blasting

The development of a mobile drill carriage to be used in advancing a face 56 ft. wide by 28 ft. high was one of the major problems. Since trucks were to be used exclusively for muck removal, rail-mounted equipment was out of the question. After considerable study an experimental carriage was built, which mounted drill bars on a timber frame constructed on the platform of a 5-ton pneumatic-tired truck.

The success of this first piece of equipment led to extending and refining the design until the carriage finally consisted of a welded structural-steel frame carrying five horizontal drilling bars. This unusual piece of equipment is shown in Fig. 3. Each drilling bar carried six drills, and the frame provided working platforms for the crew, for lights and for connections for air and water lines. When in operation the drilling end of the frame at the rear of the truck was jacked up off the wheels to remove the vibration from the truck frame and to steady the carriage. The front end of the truck was blocked tight to maintain its position but was not lifted off the front tires.

Before spotting the drilling carriage for each round the face was painted with center and side lines for correct line and grade as directed by government engineers. With the aid of these guide lines the carriage was backed into position at one side of the face (Fig. 4), and in this position the drills covered half the area of the bench face. Drill steel was brought in by trucks, air and water lines were connected, the frame was jacked up and drilling started. The average crew was 45 men, and at each of the two settings 55 holes were drilled for an average round. The crew working on the upper levels used red lights to inform the men on the lower part of the carriage when steel was to be removed or the holes blown. During these operations the men on the lower platforms would retire under the planks for protection. The drilling crews—in fact, all workmen engaged in

Fig 4—Backed against the face, the carriage is manned by a crew of 45 men and drills the 110 holes for the 17½-ft. round in an average time of 2½ hours.



tunneling operations—are required to wear miners' hard hats.

In common with usual tunnel practice, final decision as to the drilling of any individual round involved a certain element of personal judgment determined by the condition of the face and the way in which the preceding round had broken. If, for example, the floor had broken lower than usual on the previous round, the top holes were given a steeper pitch upward because of the greater overburden. However, in general the drilling for bench enlargement was standardized as shown in Fig. 2.

The upper and second row were drilled by the machines on the top bar, first with the machines over the bar and then under. The next three rows were drilled from the three center bars, and the two lower rows were drilled from the lowest bar, with the machines first over and then under. The face was often quite irregular and sloped slightly forward near the top. As a result, the starter steels for the upper drills were occasionally 12 ft. long, and the final steel was 20 ft. long during early stages of tunneling and was later increased to 23 ft.

The holes were loaded from the carriage, leaving at least one row of empty holes between loading and drilling. As soon as the first set of holes had been completed and loaded, the carriage was let down off the jacks and moved over to the other side of the heading for the second half of the round. This operation required about 15 min. Drilling for the second half of the round was a repetition of the first. The time required for drilling a round averaged about 2½ hours, although rounds occasionally were drilled in 1½ hours.

Upon completion of the drilling and loading the use of the carriage was over for the round, and under ordinary procedure it was removed from the tunnel and was available for drilling in the adjacent tunnel. When operations were at their maximum, four drill carriages were in operation, one for each pair of headings and one kept in reserve.

The shooting was the last operation of the drilling crew on leaving the heading. The average round for the 120 holes (including the 30 wing holes) consisted of 2,000 lb. of 40 per cent explosive. The average advance per round was 16-ft., the volume of rock in bench and wings totaling 1,056 cu.yd. The firing sequence for the round is shown in Fig. 2. After the two instantaneous shots to open the wings into the heading, the delays began, with the breaking contours on the bench opening out from the top center wider and deeper, until the fifteenth delay fired the two bottom corner lifters. Two primers were used for all the bottom lifters.

To clear the 12x12 heading of the spoil from the wings, 30 sticks of explosive were placed on the floor of the heading about 4 ft. in front of the back end of the wing holes and were fired on the fifteenth delay, using two primers. This shot opened up the top center heading out onto the upper bench to permit a 30-hp. tractor with bulldozer to come out from the heading and push the rock off the bench onto the main muck pile. As soon as the bench was cleared, the drilling crews for the wings began to set up the columns and proceed with the next round.

Removing muck

While the broken rock from the upper bench was being pushed off by the bulldozer, a 60-hp. tractor bulldozer was clearing up the floor for the shovel and trucks. As soon as the way was cleared, the electric shovel moved up from its station farther down the tunnel and mucking began.

The electric shovels were 2¼ yd. but were equipped with 3½-yd. buckets. No difficulty was experienced in handling all the rock with the large-size bucket without further shooting. The width of the tunnel permitted a shovel swing of only 75 deg. in loading the trucks (Fig. 5), which made loading very rapid, the trucks moving in and out in double line. The mucking crew at the face was unusually small for the yardage removed and consisted of shovel runner, oiler, helper and three or four laborers to assist in clearing up. As the work neared completion, the tractor bulldozer assisted in clearing up the last of the loose material. In addition to removing the muck pile, the shovel loosened and brought down all shattered material from the face to prepare it, as far as possible, for the next round of drilling. The average mucking time for a round was about nine hours.

The removal of excavated material was exclusively by trucks. During maximum operations about 100 trucks, varying from 5 to 14 cu.yd. in capacity, were employed. The dump bodies were built of ⅝-in. plate with reinforced sliding plates on the bottom and a special hood over the driver's head for protection. The type of truck body is shown in Fig. 6.

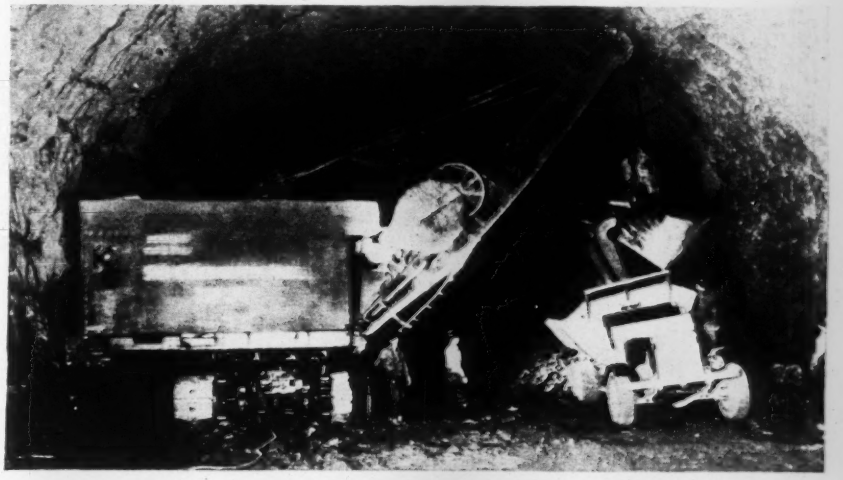


Fig. 5—Equipped with a 3½-yd. bucket, this 2¼-yd. electric shovel is mucking the 1,000 cu.yd. of the bench round. Mucking time averages 7 to 9 hours, and hauling is all done by trucks. This picture illustrates the size of the diversion tunnel; a 14-ft. depth of invert remains to be excavated.

Although the construction program called for a regular periodic servicing of the truck fleet, the speed of operations during maximum production and the continuous demand for all available equipment resulted in the trucks receiving little or no attention, aside from the driver's oiling, except in cases of breakdown. Upon removal from service the trucks were taken to the main garage at Boulder City to be reconditioned and serviced. Both pneumatic and solid tires were used extensively on the rear wheels; the front tires were exclusively pneumatic.

During the peak period of excavation the length of haul to dumping areas from the downstream portals was about 1 mile, most of which was up 10 and 12 per cent grades; at the upstream portals the haul averaged about ¾ mile. Disposal of tunnel material was a particularly difficult problem because of the rigid requirements of the specifications about dumping in the canyon area. As a result, particularly at the downstream portal, roads were extended upgrade on the canyon walls until levels were reached at which dumping was permitted in narrow side canyons. At one location on the Nevada side a 385-ft. tunnel was driven through a narrow ridge to provide an outlet for dumping in an area otherwise unavailable.

On the downstream Arizona side the trucking road was continued up the canyon wall, filling in as much area as possible, and was then turned back upstream to open up the location of the Arizona spillway, which is otherwise inaccessible.

Speed of driving

Enlargement operations were programmed for two rounds in 24 hours, although on exceptional occasions three

complete rounds were made. The routine time for a typical round was: drilling and shooting, 3 hours; clearing up, 1 hour; mucking, 7 to 9 hours, or an 11- to 13-hour cycle. The equipment to carry out this cycle in eight headings included eight shovels, four drilling carriages, four 60- and four 30-hp. tractors. The carriages alternated between headings, but the shovels remained in the tunnel and were removed about 300 ft. from the face when blasting.

Ten steel sharpeners operated three shifts in shops at both portals during the major part of the tunneling work. When all the bench carriages were in operation, 97 tons of drill steel was in circulation for tunnel driving. The loss of drill steel averaged 0.32 lb. per cubic yard of rock, including wear, loss and breakage.

January was the record month of tunnel excavation and bench progress. Prior to that time the rate of bench enlargement had been increasing, both due to the opening up of additional headings and the perfecting of equipment and organizational routine. During February a flash flood interrupted operations for about two weeks, and the effect of the flood combined with the fact that two of the tunnels had been holed through resulted in a tapering off in the volume of tunnel work.

In January the bench enlargement was advanced 6,747 ft. in the eight headings, and 446,818 cu.yd. of rock was excavated. In the preceding month the progress had been 3,844 ft. and the excavation 251,814 cu.yd., although some of this rock came from the 12x12-ft. headings that were completed about the end of December. February showed figures considerably below January because of the flood and the fact that two tunnels were holed through early in the month. Figures from the contractor's records for the months of principal tunneling progress, broken down into individual headings, are shown in Tables I and II. Table II shows that 911 ft. of bench advance was made during January in upper tunnel No. 2, and the average per heading for the month was 843 ft. for all eight headings.

The best day's record for the eight headings was made Jan. 20, when 256 ft. of progress was made, involving the removal of 16,731 cu.yd. of rock. The best week's record for a single heading was made in the first seven days of February in the inlet end of No. 4, when 21 shifts advanced the heading 246 ft. in fourteen rounds, or an average of 17.57 ft. per round. The excavation for this week amounted to 16,788 cu.yd. During a two-weeks' period in the latter part of January the average tunnel excavation amounted to about 15,000 cu.yd. every 24 hours.

Such remarkable tunneling progress was due primarily to three factors: (1) the manner in which the rock broke and handled; (2) the amount of the equipment available and the effectiveness of the drilling carriages; and (3) the size of bore, which permitted large excavating equipment and fast transportation. In addition, the personnel of the organization was exceptionally high class.

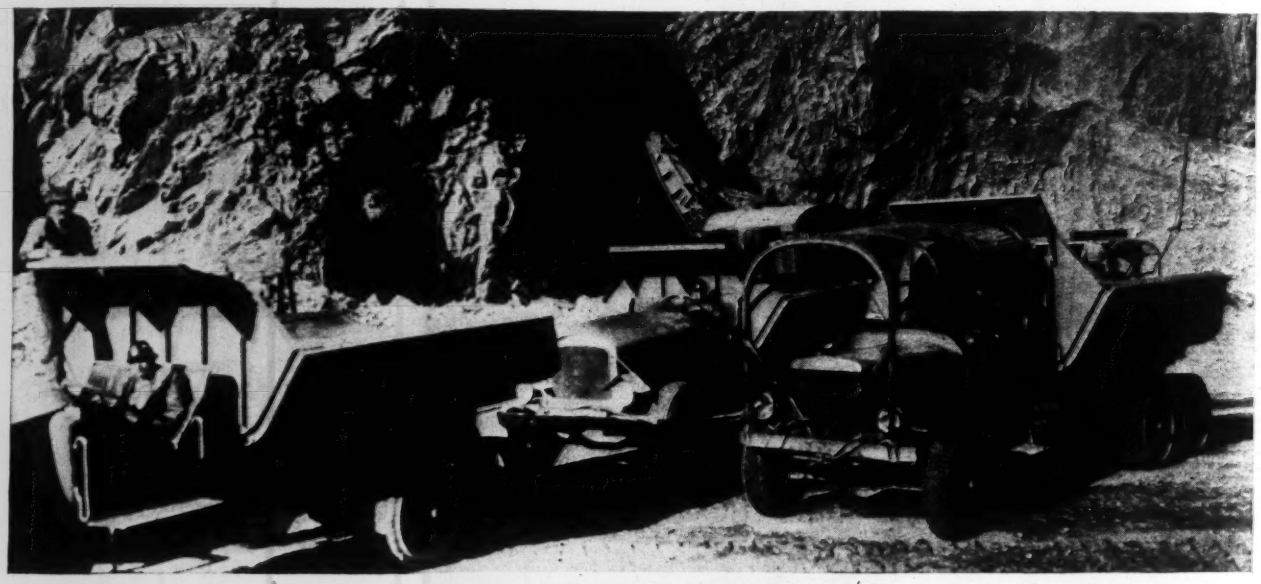


Fig. 6—Units in the fleet of 100 trucks used for tunnel excavation. Dump bodies ranged from 6 to 14 cu.yd. in capacity. All bodies had extensions for protection of the driver, and some were provided with screens over the hood as shown.

Ventilation

Air conditions in the tunnels where trucks were operating during periods of rock removal have occasioned considerable discussion, although the effect of exhaust gases under the existing conditions was theoretical rather than actual. Air tests in the tunnels during maximum trucking operations showed conditions to be better than those in the ordinary vehicular tunnel. Testing equipment did not register carbon monoxide in appreciable amounts. The convection currents in the large bores produced a natural ventilating effect, which of course diminished as the heading advanced from the portal.

To supplement this natural ventilation, blowers were placed in the top headings just inside the intersection with the adit. These blowers forced fresh air through the headings and down over the face of the bench during both drilling and mucking operations. To assist in exhausting this air out of the main portal and to assure continuous circulation, fans were set up in the main tunnel at advantageous points, determined by a study of air conditions, and were kept in operation constantly while work was advancing in the tunnel. As a result, air conditions in the tunnels offered no actual trouble, and the tests proved that fear as to the effect of exhaust gases was unwarranted.

The fact that the Nevada state law prohibits the use of combustion engines in underground workings was made the basis of a suit to stop trucking operations. A recent decision in this suit permits the continued use of trucks within the tunnels. The law that was designed primarily for mining operations with small shafts and tunnels is hardly applicable to the present conditions. The fact that the government has not interfered with the operations of the trucks in the tunnels indicated that their use, under the ventilating conditions provided by the contractor, was not harmful.

Scaling and invert

Following up the bench enlargement, the next operation is the scaling of the

TABLE I—TUNNEL EXCAVATION PER MONTH, IN CUBIC YARDS

Heading	Prior to Nov.	Nov.	Dec.	Jan.	Feb.
Lower 1	.....	.....	23,469	59,403	32,300
Lower 2	.....	32,620	39,270	56,270	6,525
Lower 3	.....	31,330	41,890	56,610	7,385
Lower 4	.....	26,760	44,080	54,030	7,425
Upper 1	.....	.....	3,025	56,670	18,363
Upper 2	.....	10,090	36,890	58,290	11,365
Upper 3	.....	9,300	33,450	51,745	11,090
Upper 4	.....	12,355	29,740	53,800	28,235
Total		137,747	122,455	251,814	446,818	122,688

Top headings completed during December. January figures include only bench enlargement. February figures include 39,660 cu.yd. of invert excavation.

TABLE II—PROGRESS OF BENCH ENLARGEMENT PER MONTH, IN FEET

Heading	Prior to Nov.	Nov.	Dec.	Jan.	Feb.
Lower 1	.....	.....	389	886	499
Lower 2	.....	495	609	885	†81
Lower 3	.....	458	637	832	*.....
Lower 4	.....	394	677	841	30
Upper 1	.....	.....	40	824	175
Upper 2	.....	150	570	911	†59
Upper 3	.....	132	504	780	*.....
Upper 4	.....	180	418	788	414
Total		685	1,809	3,844	6,747	1,258

*Tunnel No. 3 holed through Jan. 30.
†Tunnel No. 2 holed through Feb. 4.

walls to insure that the tunnel section will meet the minimum specification requirements. Scaling is done from a specially constructed carriage of structural steel, which operates on rails set on the floor of the bench. This carriage is circular down to the invert section, and the outer line is 50 ft. in diameter. With the rails set at proper line and grade, the scaling carriage perimeter indicates the finished line of the tunnel lining. Measurements from this carriage (Fig. 7, background) permit locating, plugging and shooting projections inside the minimum line. Also the government surveyors are able to measure the cross-section and check clearances. Rock fragments removed in scaling are left on the floor and removed with the subsequent invert excavation.

Truck-mounted carriages for removing the invert were remodeled from the bench carriages after they had completed the enlargement. The arrangement of the drilling equipment is different, but the general mounting is similar. The lower drill bar is curved in the form of an arc along the invert line, and in addition two horizontal bars are provided at higher levels to drill inside holes. For ease in handling, the wing sections are hinged and are fastened back against the frame (Fig. 7) during moving. One setting is made on the center line, which is sufficient to drill the 28 holes required for the invert round. The curved lower bar mounts twelve machines, and the upper bar carries six. Operations with respect to connecting with air and water lines, jacking up the frame and drilling are closely similar to those for bench enlargement.

The 28 holes that constitute the invert round required about 1½ hour for drilling; their location and direction are shown in Fig. 2. The round is loaded with 1,000 lb. of 40 per cent explosive,

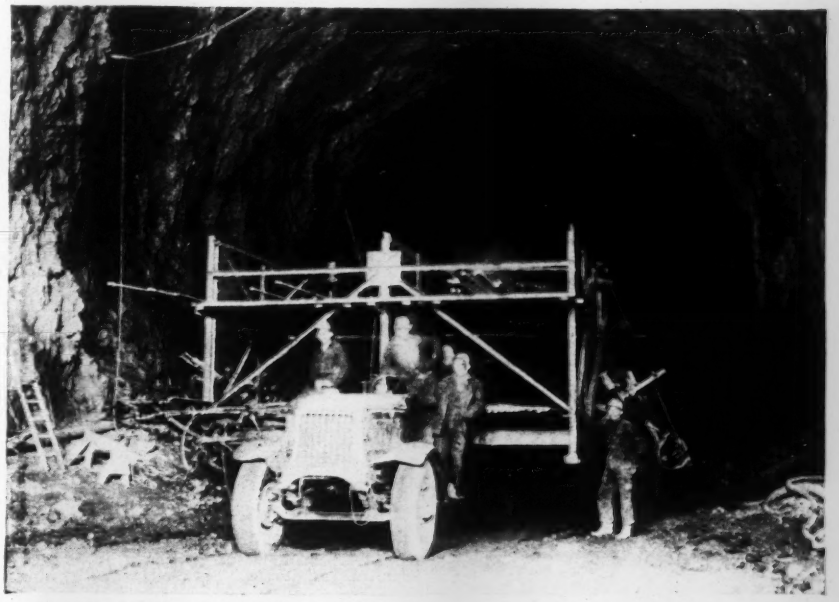


Fig. 7—Trimming and invert operations followed bench enlargement. In background is structural-steel trimming carriage. Invert drilling carriage on truck carries eighteen drills. Wings are swung out at right angles for drilling.

and the average advance is about 20 ft. The sequence of operation for the invert is in general similar to that for bench enlargement.

Following drilling, the carriage is removed to the other heading, the round is shot and the shovel is moved into position. Because of the narrower section the shovel is required to make a 180-deg. swing to load the trucks, which have to remain on the portal side, and this makes the work of mucking somewhat slower. The time for the removal of the 320 cu.yd. for an average round is 3 hours. To permit the swing of the shovel cab, about 2 ft. of loose material is allowed to remain on the floor. This material will be removed with the final clean-up before lining. Invert removal began in January and is now in progress in several headings.

Concrete lining

Lining operations are just getting under way, and final plans as to equipment and procedure have not been completed. However, it is possible to outline the tentative plan. The lining, according to specifications, is to be a 36-in. average thickness of unreinforced concrete, with a 24-in. minimum and a 42-in. maximum, the latter figure being the outside pay line.

The present plans of the contractor call for the lining to be placed in three separate operations. The invert will be placed from a gantry running on rails supported on concrete ledges along the side of the tunnel. Concrete will either be transported by 4-cu.yd. agitator-body trucks or 2-yd. buckets transferred to bottom-dump buckets handled by the gantry. The second operation will be the placing of the side-wall concrete, which will also be done by gantry equipment lifting the buckets and depositing concrete through openings in the steel forms. The side walls will be completed up to a 110-deg. arc of roof section. This final section will be placed pneumatically as the last step in the lining procedure.

The operations of the Six Companies Inc. are under the personal direction of Frank T. Crowe, general superintendent, reporting to the board of directors of the organization; Charles A. Shea is the resident director, A. H. Ayers is chief engineer, and Bernard Williams, assistant superintendent, is in charge of work in the canyon. Floyd Huntington is tunnel superintendent. Supervision of the project by the Bureau of Reclamation is in direct charge of Walker R. Young, construction engineer, reporting to R. F. Walter, chief engineer, Denver office. John C. Page is office engineer, Ralph Lowry, field engineer, and Paul Jones is field inspector of tunneling.

Largest Quarry Blast

The largest quarry blast ever fired is said to have been that of 220 tons of dynamite at the quarry of the Inland Lime & Stone Co. (subsidiary of the Inland Steel Co., Chicago) about 20 miles from Manistique, Mich. On a rock area 4,400x200 ft., 4,030 holes 6 in. in diameter were drilled, aggregating more than 125,000 ft., or an average depth of 31 ft. Each hole was measured for depth and charged with a specified quantity of explosive. It is estimated that 1,200,000 tons of rock was displaced. The blast was fired March 16, and though the shock was not severe locally it was recorded on instruments at Washington, D. C.

Concrete Water Conduit Tapped While in Service

Modified pneumatic caisson enables openings to be made in filtered-water conduit to connect it with new weir chamber

By Eugene A. Prokop
Assistant Engineer of River Tunnels, Detroit Department of Water Supply

THE PRINCIPLE of the diving bell was successfully applied recently at the Detroit filter plant to the task of making a large connection between the concrete filtered-water conduit and an adjoining closed weir chamber, without taking the conduit out of service. The work was carried on from within the weir chamber, the compressed air preventing the water from rising as the opening was made in the wall of the conduit.

The weir chamber and an additional filtered-water reservoir were built to provide additional storage and to equalize the output of the filtration plant. The weir chamber is a regulating structure designed for the "shunt system" of operation described in *Engineering News Record*, Dec. 26, 1929, p. 1011, and built to provide an emergency supply of raw water to the high-lift pumps. To put it into operation required the enlargement of one timber bulkheaded opening in the conduit wall from 6x6 ft. to 8½x8 ft., cutting a new opening in the wall 8½x8 ft., the removal of a timber bulkhead from another large opening, the construction of a short section of conduit inside the weir chamber, and the removal of a brick bulkhead containing two 48-in. valves at the dead end of the raw-water conduit. An attempt was made to do this work by bypassing the low-lift pumps and filter plant and pumping chlorinated raw water into the distribution system, but it was found that the loss of head between the intake and the high-lift pumps was too great to spare the low-lift pumps.

The writer proposed doing this work without putting the conduit out of service by a method based upon the principle of the diving bell. As the entire filtered-water supply of the city of Detroit depended upon maintaining this conduit in service, it was imperative that the method used be safe. The method was accordingly submitted to the department's consulting engineers, the late Gardner S. Williams, Clarence W. Hubbel and Prof. W. C. Hoad, who approved of its use.

One section of the weir chamber was converted into a caisson by placing a timber bulkhead across the open end. The material lock was built into this bulkhead. A timber deck weighted with brick was laid across the top, and a man lock of the side-door type was installed. The compressed air for the caisson was furnished by one electrically driven air compressor and a portable gasoline air compressor for stand-by. Compressed air for cutting tools was furnished by two portable gasoline compressors. A safety platform at an elevation higher than the maximum height that water could rise in the caisson was provided. The scaffolding was so arranged that the working platform could be easily raised from one position to another.

The wall was removed in four horizontal sections, as shown in Fig. 1. The side wall of the conduit was 30 in. thick and heavily reinforced in both directions in both faces. In starting a cut, about 18 in. of the thickness of the wall was first removed, to reduce the weight of section to be handled. A paving breaker suspended horizontally could be used to good advantage on this part of the work. A horizontal top groove and vertical end grooves 10 in. deep were then cut in the remaining 12-in. thickness of wall, which virtually detached the section from the wall above. The horizontal reinforcing bars were then burned off. At this stage the section was held up largely by the vertical reinforcing steel on the inside of the conduit. Before these bars were burned off the section was secured by rope slings, facilitating its landing on the platform after it was detached. The holes for the slings were drilled through the concrete into the water and plugged with clay after the slings had been passed through. After the vertical bars were burned off, a few blows with a heavy sledge were usually all that was required to crack off the section along the groove. The sections were then landed on the working platform and broken up into pieces small enough to pass through the material lock. Because of lack of head room the top section was detached by jacking against it

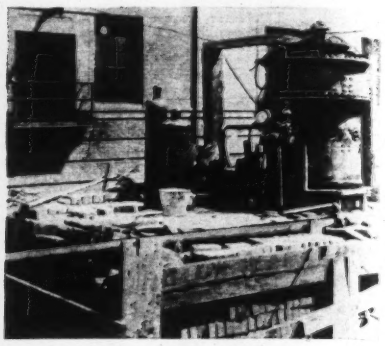


Fig. 1—Pneumatic caisson made by covering weir chamber with a timber deck heavily loaded with brick and providing it with an entrance lock.

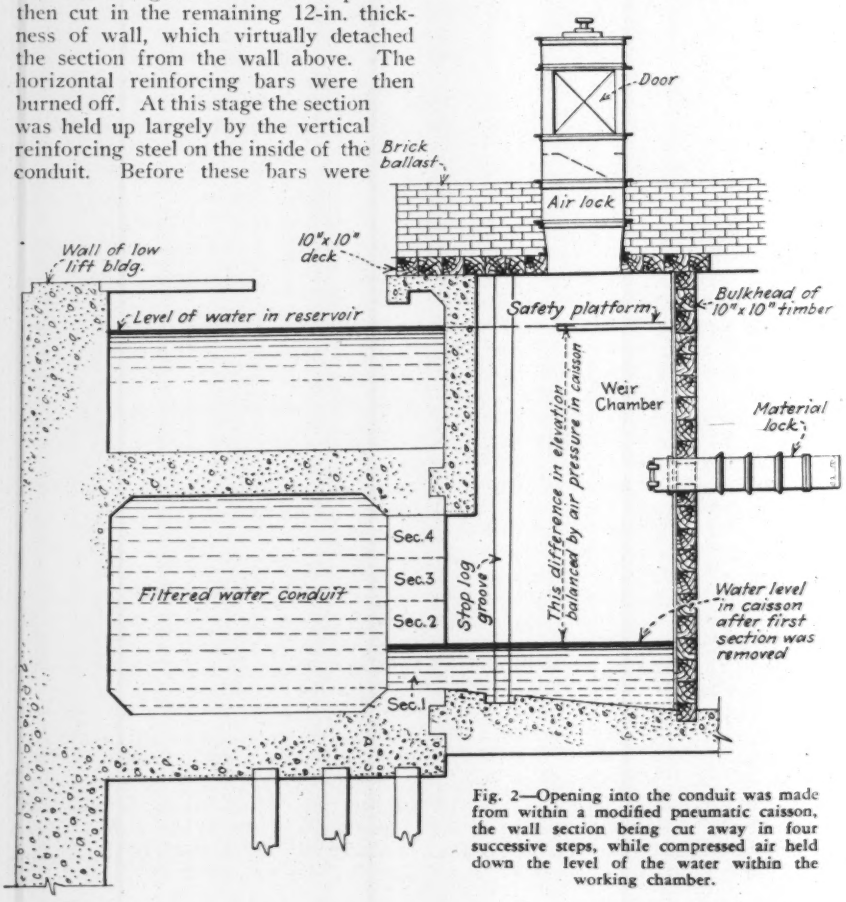


Fig. 2—Opening into the conduit was made from within a modified pneumatic caisson, the wall section being cut away in four successive steps, while compressed air held down the level of the water within the working chamber.

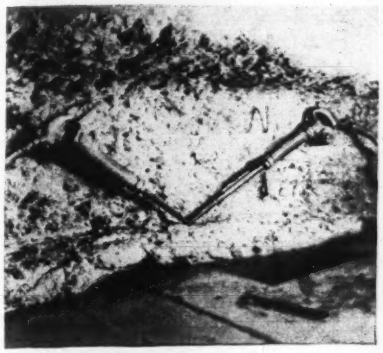


Fig. 3—Water level in the working chamber was automatically stabilized at the highest completed point of the opening by compressed air.

with screw jacks set against the wood bulkhead.

When the opening was completed an inspection screen was installed, as shown in Fig. 3, so that by means of marine lights dropped into the conduit the entire opening could be seen. As great care had been taken in cutting the grooves on the four sides, the resulting opening presented a fairly smooth surface.

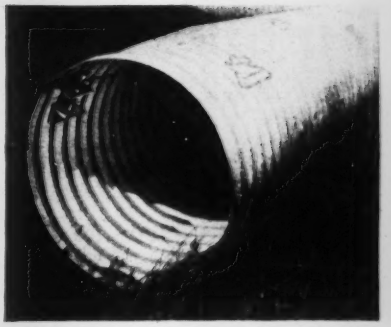
Rigid sanitary rules were enforced throughout the work. The working platform was kept tight, and all debris from the cutting operations was sacked and promptly removed from the caisson. The small amount of debris that dropped to the bottom of the conduit was removed periodically with a telegraph spoon.

The maximum velocity in the conduit while this work was being done was 3½ ft. per second. The maximum air pressure required was 7 lb.

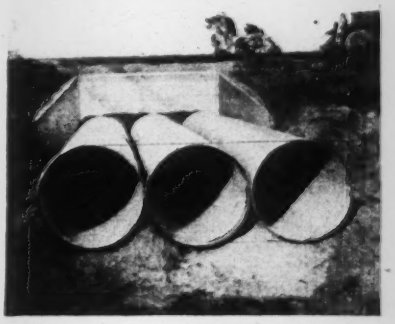
With some modifications, the same method was used in removing the two 48-in. valves and brick bulkhead. Here the height of wall removed was 12 ft., and the maximum air pressure required was 12 lb.

The work was carried on in three shifts with a crew of five men inside the caisson. The men were picked from the water department's construction forces and were under the direct supervision of the writer.

George H. Fenkell is general manager and chief engineer, department of water supply, and Frank H. Stephenson is assistant chief engineer. Torris Eide was assistant engineer and the writer designing engineer.



Expansion-contraction end of the corrugated pipe. There are no rivets in the horizontal seam at the left, but after the pipe is in place, bolts are used along this seam.



Triple 24-in. corrugated pipe extension for 2x6-ft. box culvert, wired together; the junction with the box has been sealed with concrete.

Concrete Culverts Lengthened With Corrugated-Iron Pipe

By H. A. Pabst
Resident Engineer, Minnesota Highway Department, St. Paul, Minn.

IN WIDENING a section of highway between Benson and Hancock, Minn., 23 concrete culverts built to the 30-ft. roadway standard of 1921 required lengthening to meet the new width of a 20-ft. pavement, two 8-ft. shoulders and 1-on-3 shoulder slopes to the bottoms of the side ditches. As the center line of the new road was the same as that of the old road, the 30- to 34-ft. culverts had to be lengthened at both ends an average total of 18 ft. One culvert was 6 ft. wide, and five were 4 ft. wide, but the others were of 2-ft. span. Lengthening with concrete requiring new head walls was expensive and required time, which could not be afforded as the widening was a rush operation. It was decided to make the extensions of corrugated-iron pipe, and the accompanying illustrations show the method adopted.

The difficulty of connecting the metal pipe with the concrete-box culvert end was worked out by the engineers of the Lyle Culvert & Pipe Co., who designed a 24-in. pipe with an expansible end. These special pipes were built to measurement for each culvert. Briefly, the pipe was built with expanding and contracting lugs (angle irons) at one end. The longitudinal seam of the 2-ft. section that was to connect to the box culvert was punched in the shop, but no rivets were put in until the pipe was in place.

Installing the pipe

The flow line was graded at both ends of the existing boxes. Before the pipe was placed, the ends were contracted by the use of the angle irons and bolts, so they would slip easily into the box, about 1 ft. After the pipe was placed, the ends were expanded to fit snugly within the box. This was accomplished by removing and changing the bolts, putting both the shouldered head and the nut inside the angle irons. Then, by turning the nut toward the end of the bolt, the sheets were spread and the culvert was expanded to its normal diameter. As soon as the pipe was expanded to normal size, bolts were placed in the longitudinal seam of the last section, where the rivets had been omitted in fabrication. Field-riveting was not considered practicable on this size structure.

Preparing to extend a 2x6-ft. concrete box; the streambed has been carefully leveled off to give proper flow line.

The culverts of 4- and 6-ft. span were extended with two and three parallel lines of 24-in. pipe respectively. Where the extensions were double or triple, the pipes were bolted firmly together to alignment and grade.

Watertight joint

The space between the concrete boxes and the corrugated metal pipe was sealed with concrete of 1:2 mix. On all bottom corners and spaces between parallel lines of culverts the concrete was beveled off back about 6 in. into the box. This gave a good watertight joint and increased the hydraulic efficiency of the connections.

These extensions were made without any delay to the contractor who was doing the shouldering; the day after their placement he was able to fill over the pipe. The lengths of the extensions varied from 12 to 18 ft. and were ample to make new head walls and wing walls unnecessary.

Simplifying Reinforced Concrete Beam Design

By use of special equations and constants steel areas are determined with only three lines of computation—Charts for checking and estimating

By Odd Albert
Structural Engineeer, East Orange, N. J.
Former Professor of Mathematics at West College, Sweden

SHORT CUTS in design are always useful. The data presented here on rectangular concrete beams deal with beams reinforced for tension and for both tension and compression and include several design charts that can be used to advantage for estimating and checking purposes. Attention is especially called to Fig. 3 where several different concrete stresses are introduced on one chart. Here the assumption is made that $nf_c = 12{,}000$, so that for $f_c = 1{,}200$, $n = 10$; for $f_c = 1{,}000$, $n = 12$; and for $f_c = 800$, $n = 15$. Standard notations are used throughout.

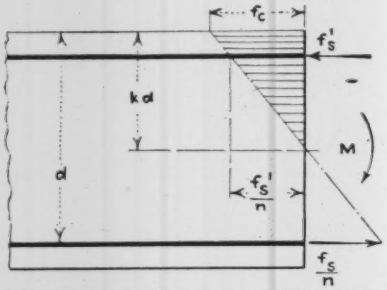


Fig. 1—Standard nomenclature for a concrete beam reinforced for both tension and compression.

Tension steel only

In a concrete beam with only tensile reinforcement the compressive concrete stress is

$$f_c = \frac{2\,M'}{jkbd^2} \qquad (1)$$

and the tensile steel stress

$$f_s = \frac{M'}{A_s jd} \qquad (2)$$

where M' is the bending moment in in.-lb. The position of the neutral axis is determined by

$$k = \frac{1}{1+m} \qquad (3)$$

where $m = f_s/nf_c$, and the ratio of lever arm of the resisting couple

$$j = 1 - \frac{k}{3} = \frac{3\,m+2}{3\,(1+m)} \qquad (4)$$

By changing the moment to foot-pounds we get from equation (1)

$$f_c = \frac{24\,M}{jkbd^2} \qquad (5)$$

and with the product

$$jk = \frac{3\,m+2}{3\,(1+m)^2} \quad \text{we get}$$

$$f_c = \frac{72\,M\,(1+m)^2}{(3\,m+2)\,bd^2} \qquad (6)$$

or

$$d = K_1\sqrt{\frac{M}{b}} \qquad (7)$$

Similarly we get from (2) the tension steel area

$$A_s = \frac{M}{K_2 d} \qquad (8)$$

where K_1 and K_2 are values, constant for known stresses (which are given in the accompanying table) and M is the moment in foot-pounds.

Compression and tension steel

If compression steel is required in a section, then such an amount of tension steel must also be added, so that the compression and tension steel form a balanced couple in which the stresses must conform to the stresses already in the section. Therefore, the value of k will be the same as for a section with only tension steel. Hence

$$k = \frac{1}{1+m} \qquad (9)$$

and the tension steel area will also be the same as before, or

$$A_s = \frac{M}{K_2 d} \qquad (10)$$

This is on the assumption that the compression steel is located $\frac{kd}{3}$ down from the top. The average value of k is 0.36, and therefore if $\frac{d'}{d} = 0.12$, the

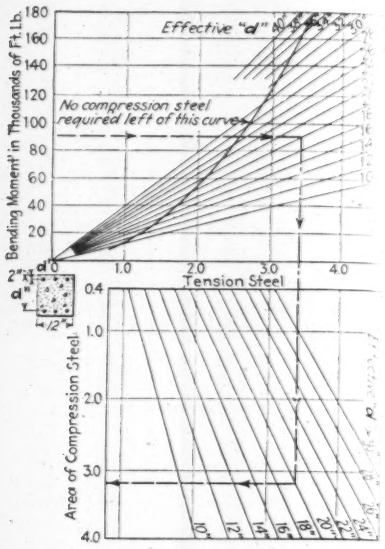


Fig. 2—Beam design chart suitable for use with a given single concrete stress. Other values used are: $f_s = 18{,}000$; $f_c = 750$; $n = 15$; $d' = 2$ in.; beam width = 12 in.

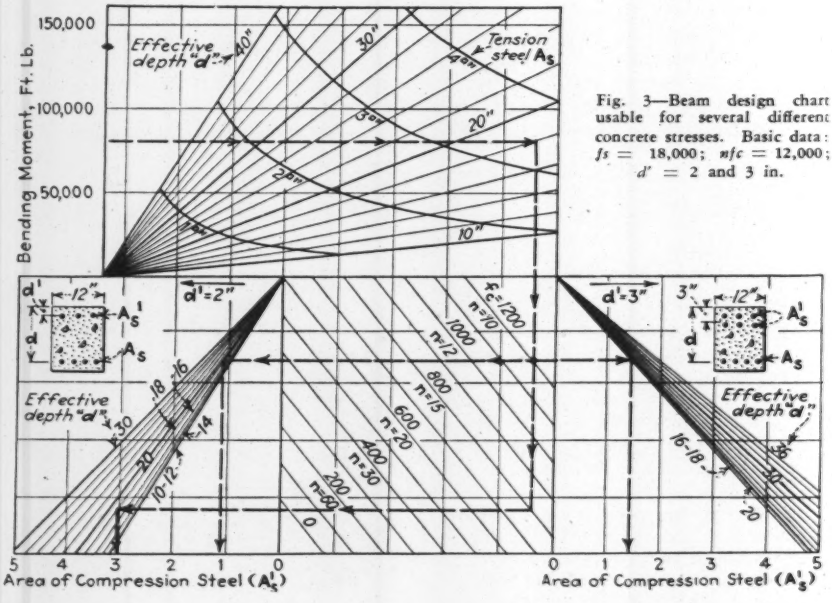


Fig. 3—Beam design chart usable for several different concrete stresses. Basic data: $f_s = 18{,}000$; $nf_c = 12{,}000$; $d' = 2$ and 3 in.

TABLE OF BEAM DESIGN CONSTANTS

Ratio $\frac{d'}{d}$	Values of K_1 (f_s = 18,000; n = 15)			
	f_c = 650	f_c = 700	f_c = 750	f_c = 800
0.20	4.74	4.11	3.64	3.06
0.18	4.08	3.59	3.19	2.71
0.16	3.56	3.17	2.84	2.43
0.14	3.15	2.77	2.55	2.19
0.12	2.81	2.53	2.30	1.99
0.10	2.54	2.29	2.10	1.81
0.08	2.30	2.09	1.91	1.66
0.06	2.10	1.91	1.76	1.53
K_1	0.344	0.326	0.309	0.294
K_2	1325	1315	1309	1300
p_0	0.0063	0.0072	0.0080	0.0089

assumption is correct. The actual location of the compression steel is considered in the following derivation.

Similar triangles (Fig. 1) give the compressive steel stress

$$f'_s = n f_c \left(\frac{k - \frac{d'}{d}}{k} \right) \qquad (11)$$

and a moment equation around the tension steel gives

$$\tfrac{1}{2} f_c b\, kd \left(d - \frac{kd}{3} \right) + f'_s A'_s (d - d') = M = A_s f_s jd$$

With $\frac{f_c k}{2f_s} = P$ and $\frac{f_s}{f'_s} \left(\frac{j}{1 - \frac{d'}{d}} \right) = K_3$,

the general formula for the compression steel area will be

$$A'_s = K_3 (A_s - p\, bd) \qquad (12)$$

where p is the steel ratio and K_3 is a constant, both given in the accompanying table.

With the help of formulas (7), (8) or (10) and (12) any kind of a rectangular beam may be designed. Formula (7) gives the required depth for tension steel only and indicates whether or not compression steel is required. Formulas (10) and (12) give the amount of reinforcement steel.

Example—A beam 12x22 in. takes a moment of 90,000 ft.-lb. If the allowable stresses are f_s = 18,000 and f_c = 750, find the reinforcement.

Required depth for tension steel only

$$d = 0.309 \sqrt{\frac{90{,}000}{12}} = 26.7 \text{ in.}$$

As the effective depth is limited to 20 in., compression steel is required. The tension steel will be

$$A_s = \frac{90{,}000}{1309 \times 20} = 3.40 \text{ sq.in.}$$

For the design of the compression steel, use the ratio $\frac{d'}{d} = 0.10$.

Then $A_s' = 2.10\ (3.40 - 0.0080 \times 12 \times 20) = 3.20$ sq.in.

The simplicity of this design, where only three lines of computations are required, is notable.

Design charts

For checking and estimating purposes the accompanying charts may be useful. They are supposed to be worked the way the dotted lines indicate, but they can of course also be used backwards. These charts are built up to fully mathematical derivations, and there are no approximations involved. It will be noted that mostly straight lines are used. Similar charts may be plotted without difficulty conforming to required stresses and regulations.

The chart in Fig. 2 gives tension and compression steel for f_s = 18,000 lb. per sq. in. and f_c = 750 lb. per in. The dotted lines indicate how the chart should be used. The width of the beam is always assumed to be 12 in. If a beam 24×30 takes a moment of 200,000 ft.-lb., in using the chart reduce the moment to that for a 12-in. width or 100,000 ft.-lb. A cover d' = 2 in. has been assumed, so that the effective depth is immediately available, thus eliminating one slide-rule operation.

The chart in Fig. 3 gives tension and compression steel for f_s = 18,000 lb. per sq.in. and for various concrete stresses, with the assumption than nf_c = 12,000. A beam 12x20 in., taking a moment of 80,000 ft.-lb., is assumed. The dotted lines indicate how the chart is used. For d' = 2 in. go to the left, and for d' = 3 in. go to the right. The first turn is for f_c = 1200 and n = 10, and the second turn is for f_c = 800 and n = 15. The chart gives the compression steel for these two conditions to be 1.1 and 3.0 sq.in., respectively. If d' = 3 in., the area of compression steel required is 1.4 sq.in. By starting from each end the intersection of the dotted lines might give either the required depth or the resulting concrete stress. This chart also is designed on the assumption that the width of the beam is 12 in. For other widths reduce the moment to correspond to a width of 12 in. The curves in the upper part of the chart give the tension steel.

New Tools for Sheet Asphalt on St. Louis Streets

A HEAVY RAKE to break up lumps and a power grinding machine to remove high spots were successfully used in St. Louis, Mo., in laying sheet-asphalt pavements in 1931. These machines have facilitated the process of obtaining the uniformity of surface that is required by modern specifications, which in St. Louis limit the irregularity in sheet asphalt to ¼ in. as determined by a 10-ft. straight-edge.

With the relatively dry mix that St. Louis has used for several years, the pavement does not work much under the rolling, and unless the original shovel lumps are thoroughly broken there is a tendency for the rakers to comb over the top of them, leaving them as hard spots in the pavement. In the wheel rake illustrated the teeth are adjustable. The weight is carried on wheels of ⅛-in. plate so as not to flatten down the loose asphalt by wheel tracks. After the gang of rakers had been properly reorganized, it was found that the cross-raking could be done with the wheel rake without impeding progress and that a much more uniform pavement density and surface smoothness was secured. A cross-rake of this type is specified for the 1932 pavements.

The power grinding machine to remove high spots on the finished sheet-asphalt surface is essentially the same as that used on concrete pavements for several years. Heretofore high spots have been corrected by cutting out and replacing the pavement. The grinding operation is quite simple, the high spots are readily removed, and the resulting surface is quite satisfactory after it has been under traffic for a short while.

Heavy asphalt rake breaks up shovel lumps to the bottom of the mix and gives uniform pavement density and surface smoothness; teeth on weighted rake are adjustable.

High spots in asphalt pavement are removed with surface grinder commonly used for concrete.

Information on these devices comes from W. W. Horner, chief engineer, sewers and paving, St. Louis board of public service.

California Irrigation and Reclamation Bonds Hard Hit

By T. H. Means
Consulting Engineer, San Francisco, Calif.

BONDS of irrigation and reclamation districts in California have depreciated with other securities. The state led in organizing such districts and probably has a larger area of reclaimed land and a greater value of outstanding securities than any other state. In January, 1932, the average bid price for irrigation district bonds was about $40. With more than $143,000,000 in bonds outstanding and $60,000,000 of these in default, the market is disorganized and uncertain, and development is at a standstill. The problem at the present time is to reorganize those districts now in default or in danger of default and to determine the fundamental causes of failure as a guide for the future.

California has nearly a dozen statutes authorizing the formation of districts for irrigation, reclamation, drainage, and control and development of water supplies, besides several special district acts for specific committees. Only two of these types of districts have issued any substantial amounts of bonds—irrigation and reclamation districts.

District Bonds—Eighty-four irrigation districts have issued bonds in recent years; this figure leaves out of consideration the districts that issued bonds years ago and that have been inactive for a long period. In January, 1932, the active districts had outstanding $96,500,000 in bonded obligations. Of this amount 55 per cent was in default either for payments on interest or retirement of bonds. While districts in all parts of the state have defaulted, it is interesting to note that the heaviest mortality was among districts in the higher elevations where the growing season is comparatively short. Districts with a predominating single crop have been prominent among defaulters. In recent years the older districts with well-established agricultural practices and diversity of crops have been most successful. Two districts dependent upon sale of electric power for a substantial part of their income failed because of low water yield.

Reclamation districts were originally organized to levee and drain lands along the rivers. Such districts also had the power to build and operate irrigation and drainage works. More than 900 reclamation districts have been organized, but only 182 are active at present. Sixty districts have outstanding $31,500,000 in bonds, and in January, 1932, 37 per cent of them were in default.

Financial History—Both types of districts have had long and checkered financial careers. There are many cases of default in obligations in the distant past, which are now only a matter of history. Early developments in land reclamation in California were financed by individuals and corporations. Profits from irrigation enterprises were small, and the number of failures was large. When the growth of the state had reached the point where it was necessary to undertake the larger and more costly projects the irrigation district plan was proposed. The first workable act was passed in 1887, amended and rewritten several times, and is now known on the statute books as the "California Irrigation District Act." Of the 49 districts organized under the early acts only seven have survived to the present day. Four have managed to maintain their credit. The remainder either failed to function or, after assuming obligations, compromised the debt.

Bond Certification Commission—As a result of early district history, it became difficult to sell bonds at any reasonable price, and in 1911 the bond-certification commission act was passed. This commission, composed of three state officers—attorney-general, superintendent of banks and state engineer—examined district affairs, approving certified bonds as legal investment for savings banks, trust funds, etc. The stimulus thus given the bond market resulted in the issuance of more than a hundred million dollars in bonds in the next fifteen years. The period of greatest activity was in the years 1919 to 1928, coinciding with the period of easy money when stocks and bonds were advancing rapidly. Following the fall in commodity prices since 1929, irrigation districts have defaulted in increasing numbers. In January, 1930, $7,640,000 in bonds was in default, increasing to $23,734,000 in January, 1931, and $53,300,000 in January, 1932.

The difficult financial situation in which irrigation districts found themselves was so apparent in 1931 that the legislative session of that year reenacted the bond commission act, creating the enlarged "California Districts Securities Commission," consisting of the attorney-general, superintendent of banks, state engineer and two members appointed by the governor, with "at least five years actual experience in the affairs of an irrigation district in this state as an officer or employee." This organization now has a permanent office under the management of an executive secretary who is an engineer well acquainted with irrigation and reclamation. It has broad powers in the reorganization of districts and the issuance of refunding bonds and may act virtually as receiver of any district declared insolvent upon court hearing. This enlarged commission has only recently been organized and has not yet had its administrative powers tested.

The fact is generally recognized that there is going to be a heavy loss in the face value of outstanding irrigation district bonds. The districts and their taxpayers naturally desire to reduce their indebtedness or lower the rate of interest they are now obligated to pay. Bondholders, on the other hand, will resist any tendency to place the loss upon their shoulders. The state will be fortunate if both bondholders and taxpayers approach the settlement of their differences in a reasonable frame of mind.

Unemployment Relief by Sewer Construction

By Harrison P. Eddy
Metcalf & Eddy, Boston, Mass.

SEWER construction now in progress in a city of moderate size has resulted in furnishing work to local labor at a current cost (during the two years that will have elapsed when the work has been completed) amounting to only 45 per cent of the expenditure that would have been required to care for the same number of persons from welfare funds. The sewers, which were originally planned more than ten years ago, are being financed by 30-year bonds, which are fully justified since the sewers were badly needed; but the present out-of-pocket cost has been much easier to meet than would have been the cost of supporting people in idleness. The greater part of the $1,000,000 or so paid out has been expended and kept in circulation locally, thus improving the general business conditions, since the amount circulated from relief funds would have been less than one-third as much. About 60 per cent of the amount of the bonds is being paid directly for local labor. It is estimated that about 125,000 man-days of labor will be provided for within the two-year period.

The actual direct cost to the city during this time will have been about $140,000 in interest and bond-retirement funds; and it is estimated that to provide the same amount of relief through direct payments, which would have to be derived wholly from the tax levy, would have cost more than $310,000. The tax burden in these two years has been, therefore, considerably less than half what it would have been if the work had not been provided.

Engineering Literature

A Monthly Review of Books and a Listing of New Publications

Three-in-One Handbook

GENERAL ENGINEERING HANDBOOK—Editor-in-Chief, Charles Edward O'Rourke, Assistant Professor of Structural Engineering, Cornell University. New York and London; McGraw-Hill Book Co. Flexible covers; 5x8 in.; pp. 929; tables and line cuts. $4.

COMPILED by a distinguished group of 30 authors listed as "associate editors," to meet a need for data that are now found only in numerous specialist handbooks, Professor O'Rourke's "General Engineering Hankbook" is unique. The information, while necessarily abridged from that found in the specialist books, is nevertheless voluminous. Civil engineers and contractors who periodically must delve into machine elements and mechanical power transmission problems of the mechanical engineer, the heat and thermodynamics in which power plant engineers specialize, and the electricity and magnetism subjects of electrical engineering, will find especially valuable the placing of this material between covers with stresses in frame structures, hydraulics, surveying, foundations and sewage disposal. The ensemble is a three-in-one handbook.

All on Earth Dams

REVIEWED BY J. ALBERT HOLMES
Consulting Engineer, Somerville, Mass.

EARTH DAM PROJECTS—By Joel D. Justin, C.E., M.Am.Soc.C.E., Hydro-Electric Engineer, The United Gas Improvement Co. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. 345; photographs and line drawings. $5.

NOT SINCE Burr Bassell's little classic entitled "Earth Dams" was published in 1904 has a book devoted entirely to earth dams appeared. In this respect Mr. Justin's "Earth Dam Projects" becomes a milestone in the art of earth dam design and building. During the 28 years intervening much has been written on earth dams. Mr. Justin has produced a portion of this literature and has created some of the structures he now describes. The four chapters on design, including lines of saturation, cutoff sheeting and freeboard, are adapted from one of Mr. Justin's papers before the Am.Soc.C.E.

The opening chapter is devoted to earth dams that have in part or entirely failed in various ways. The cause and manner of failure of each dam is described and analyzed for the purpose of emphasizing what may be learned from failure and what should be avoided. Special emphasis is directed toward the dangerous practice of placing pipes and conduits in the embankment without adequate support or cutoff collars, also placing control gates at the downstream end. These failures are also used to indicate the importance of subsurface investigations, what should be looked for in investigating foundations and materials, what to avoid and what may be improved. Another chapter deals with preliminary studies and spillway requirements. The careful study of flood-flow and spillway capacity are stressed because of their special importance in connection with an earth structure. It is pointed out that the general procedure for investigating the hydrology of a watershed is the same whatever use is to be made of the water or by whatever type of structure it is impounded. For this reason hydrology is not taken up in the text, but reference is made to authoritative sources and data. Two chapters are devoted to surface and subsurface investigations at dam and reservoir sites and to materials of foundation and construction and their laboratory tests. It is shown that materials available and their location in relation to the work strongly influence design and methods of construction, and that a material might safely be used under one method (rolled fill) that would be unstable under another construction method (hydraulic fill). Recent laboratory procedure is cited, and equipment is described and illustrated. The extent to which geologists may assist and cooperate in foundation and material investigation is set forth, and the importance of employing recent methods in soil research is made manifest. Two chapters are given to description of methods of construction. A rolled-fill dam is described from grubbing to final trimming of slopes, and hydraulic- and semi-hydraulic-fill methods are described and illustrated.

The final third of the book is made up of well-selected and arranged descriptions of earth dams of various types and construction interest. Some of them are of notable size. The description begins with rolled-fill dams with and without corewalls and with and without core sections. Next come the semi-hydraulic-fill type and finally the straight hydraulic-fill. Some of the dams are British and have clay-puddle corewalls, but most of them are examples of American-built structures.

The volume is well illustrated with halftones and line drawings showing dams completed and in process of building, geologic and dam sections, details of apparatus and structures and tabulated data on earth dams. Throughout the text source references are given, and at the end of each chapter appears a bibliography of matter treated in the chapter. An ample index is provided.

Depression and Ways Out

AMERICA FACES THE FUTURE—Edited by Charles A. Beard, co-author of "The Rise of American Civilization" and "The American Leviathan"; sometime President of the American Political Science Association. Boston and New York: Houghton Mifflin Co. Cloth; 5x8 in.; pp. 410; $3.

A BASIS FOR STABILITY—By Samuel Crowther in collaboration with Myron C. Taylor, Alfred P. Sloan, Jr., Henry Ford, John Hays Hammond and 17 others. Boston: Little, Brown, and Co. Cloth; 6x9 in.; pp. 360; $3.

BUSINESS LOOKS AT THE UNFORESEEN—By Wallace Brett Donham, Dean, graduate School of Business Administration, Harvard University. New York and London: Whittlesey House Division, McGraw-Hill Book Co. Cloth; 6x9 in.; pp. 209; $2.50.

A PLANNED SOCIETY—By George Soule. New York: The Macmillan Co. Cloth; 5x8 in.; pp. 293; $2.50.

THE PARADOX OF PLENTY — By Harper Leech with an introduction by Virgil Jordan. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 203; $2.50.

JOBS, MACHINES, AND CAPITALISM—By Arthur Dahlberg, Ph.D. Foreword by Edward Alsworth Ross. New York: The Macmillan Co. Cloth; 6x8 in.; pp. 252; a few graphs in the text and six plates of colored flow charts of which one is a folding plate in pocket. $3.

RECOVERY: The Second Effort—By Sir Arthur Salter, K.C.B. New York: The Century Co. Cloth; 6x9 in.; pp. 346; $3.

CAUSES and consequences of business depressions, ways out of the present deep trough and plans to prevent or lessen the evils of future depressions are the subject of endless addresses, articles and books in these troublous days. Of such books, seven have been chosen for consideration here. They represent many viewpoints, all the more numerous and diverse because one book includes a series of "interviews" with 21 men, and another consists chiefly of reprints of a number of articles and addresses. Most of the authors emphasize the need for a new social order to fit the changed conditions brought on by the war and by the recent great acceleration of the industrial revolution, which has multiplied and cheapened mass production without providing corresponding capacity for mass consumption, throwing millions out of work, crippling industry and causing a hoarding of capital. The books as a whole review most of the notable plans to stabilize and curb unemployment that have been presented during the past year.

Dr. Beard's book consists of reprints of recent articles and addresses, with prefatory notes and a summing up of his own. He groups his material under two heads: "The New Intellectual and Moral Climate," and "Blue-Prints for a Planned Economy." Part I opens with "A Planless World," by Nicholas Murray Butler. The two following chapters

represent opinions of churchmen, of capital and of labor. To the question, "Must We Reduce Our Standard of Living?" Messrs. Waddell and Catchings utter an emphatic "No." Forceful articles by André Maurois on "Can Capitalism Be Saved?" and by James Truslow Adams on "The Responsibility of the Bankers" conclude the first part of the book. Dr. Beard's own "Five-Year Plan for America" opens Part II. This is followed by an address by Dr. Butler on unemployment, and a long section on the Swope plan. Following a statement in behalf of the American Federation of Labor are reprints of articles and addresses on money, security and agriculture. Two governors, a senator and the president are represented: Governor Roosevelt of New York, on agricultural planning; Governor La Follette of Wisconsin by his state plan; Senator La Follette (Wisconsin) by his proposed bill for an economic council; and President Hoover by his plan of June, 1931. The editor closes the volume with "The Rationality of Planned Economy."

A Basis for Stability

Mr. Crowther's book consists of 21 "interviews," prefaced and closed with chapters by himself. His own basis for stability is a new or amended credit system. The 21 interviews, all in the language of Mr. Crowther, present statements by as many business and industrial leaders in their own fields—some from narrow and some from broad viewpoints. Among the persons interviewed are Henry Ford (motors), Myron C. Taylor (steel), Gen. W. W. Atterbury (railroads), Martin J. Insull (utilities), and Carl Snyder, of the Federal Reserve Bank of New York, whose "A Measure for Business" presents a new and comprehensive index.

Business Looks at the Unforeseen

Dean Donham says his aim is "to define certain long-time objectives in mechanisms for the better adjustment of business to the society of which it is a part," in the hope "of preventing the next depression from assuming a magnitude comparable with this one." In Part I, "A Theory of Adjustment," he stresses the need for leadership, couples individualism with instability, correlates economic planning with both organic and social evolution and urges the importance of cooperation between government and business and the need for "central thinking." Repeatedly he asserts that business, collectively, has no brains to guide it. Part II discusses the economic plans advanced last year by Chase, Beard, Soule, the U. S. Chamber of Commerce, the American Federation of Labor, Gerard Swope and President Hoover. While finding merit in all the plans that he reviews, especially in the Hoover plan, none of them fulfills Dean Donham's conception of an adequate plan, which should be adjustable to "long-time conditions in our social environment," taking into account the "rapid changes which science and technology are causing in our external and internal environment."

A Planned Society

One of Mr. Soule's arguments for a planned society is the "organizing trait in man that prompts invention and technology—the very forces which now are seen as basic in initiating social change." The "organizing man" is "confronted by 'economic man' who is out for private gain and seeks it in chance, hunch and speculation." Earlier in the book the author says the "business cycle" is characterized as "one of the ways the business order naturally behaves," rather than as a "disease" caused by a "single hostile germ." These and other considertions lead Mr. Soule to declare a need for a "National Economic Board at the top, representing the whole public. It should be composed not of bargaining representatives of various interests, but of qualified experts representing the nation as a whole." It should have an "adequate staff of economists, statisticians, engineers and accountants."

The Paradox of Plenty

Mr. Leech goes back of the "machine age" and of the "manufacture of power" so frequently mentioned and points out that industry is today energized by "fossil fuel" instead of by the man and animal power dependent on food laboriously grown from the soil. This has been true since coal began to be widely used as fuel, but latterly there has been a profound change through the use of electricity and of oil and gasoline for the production of power. Coal-steam power necessitated concentration of factories in cities, with transportation to them of not only coal but also raw materials and reshipment of goods. Now the economies of large-scale power production are obtained at plants located at the most satisfactory points, while by the electric transmission of power, for long distances and its division into as small units as may be desired, industry is being decentralized and city congestion, with all its financial and other high costs, is no longer necessary. Presentation of these facts and their implications makes up only a small part of the topics of Mr. Leech's book, which deals extensively with the needs of adjusting industry and society to these changed conditions.

Jobs, Machines and Capitalism

Mr. Dahlberg's thesis is that scarcity of labor and of managers, to be insured by a very short working day, would give these classes wages and salaries that would enable them to buy the overproduced goods of industry and thus prevent shutdowns and depressions. A four-hour day, ordained by Congress, is suggested. This plan would curtail or cut off some "luxuries" now deemed essential even by wage earners, but there would be compensation for this in the leisure that it would provide. To illustrate his thesis, the author reviews many of the causes and evils of depressions. He also reviews capitalism and communism, as he sees them, and stoutly stands for capitalism, provided its workings in relation to industry are reformed. A considerable part of the book is devoted to an exposition of the processes of production, from the food and fuel taken from the earth through to finished and distributed goods. The author takes great pride in a series of three-dimension flow diagrams or "charts" (one large and complete, the others showing only parts of the whole). Colors are used to denote raw materials, labor, energy and purchasing power. Many other factors affecting production and distribution are charted.

Recovery: Second Effort

A world-wide view of the present depression is given by Sir Arthur Salter. At the start he says, "It is the second effort, after the first has brought disappointment, that tests the quality of a man or of an age. In this decade we have to do what we thought we had done in the last; we must re-establish a system in which man can once more, without intolerable waste or interruption, utilize resources of nature and his own skill." [Note how nearly the last eight words come to Tredgold's definition of engineering.] From the vantage point of long years of public service, during many of which he was director of the economics and finance section of the League of Nations, the author maps "the difficult country over which we have now to find our way." In four main sections he takes up "The Present Scene," "Economic and Financial Reforms," "The Political Scene" and "A Program of Action in Summary." Among the proposals in the "Program" are credit reform and assured peace.

Council-Manager Data

CITY MANAGER YEARBOOK 1932: Council-Manager Developments in 1931, and Eighteenth Annual Conference Proceedings, Association Business, City Manager Directory—Edited by Clarence E. Ridley and Orin F. Nolting. Chicago: The International City Managers' Association, 923 East 60th St. Cloth; 6x9 in.; pp. 273; $2.

BEGINNING with one city having a city manager in 1928, the year 1931 closed with 429 municipalities that had adopted the plan, although of the 39 adoptions last year, in sixteen the plan was not to go into effect until various dates in 1932. Included in the list are places in 36 American states, four Canadian provinces, Ireland and Porto Rico. The directory at the back of this volume gives for each city included the number of different managers the city has had thus far, the population, whether the plan was adopted

as a part of a council-manager charter or merely by ordinance, and the date plan went into effect. There is also given the name of the present manager, how many cities he has served as manager, the year he was appointed to his present position, and the salary he now draws—ranging from $25,000 to the exceptionally low figure of $720. A special map of manager cities is included. There is also given a list of 179 cities and their managers classed as "unofficial"—that is, where the manager is not responsible to the council for administrative duties and lacks broad powers of appointment of the administrative officers of the city. The directories are supplemented by a historical and descriptive summary of the council-manager plan. All these matters fill only a small part of the yearbook, the remainder being filled with the proceedings of the 1931 conference.

Uncommon Sense

ELEMENTS OF HUMAN ENGINEERING—By Charles R. Gow, President of Warren Brothers Co., Sometime Professor of Humanics at the Massachusetts Institute of Technology. Edited by F. Alexander Magoun. New York: The Macmillan Co. Cloth; 5x8 in.; pp. 169; $1.60.

THIRTY YEARS of experience as engineer, contractor, inventor and manufacturer, builder of the $25,000,000 Boston Army Base during the recent war, consulting engineer, gentleman of leisure (which didn't suit him), postmaster of Boston and, of late, president of a large roadbuilding concern, combined with keen observation, a sense of humor and large-heartedness, give Col. Charles R. Gow a background for filling the chair of Humanics at the Massachusetts Institute of Technology, endowed as a five-year experiment by the late William E. Nickerson. The first fruits of the endowment were recently made available to a wider circle than the listening students by the publication of "Foundations of Human Engineering" (*ENR*, Nov. 20, 1930, p. 815). Now comes "Elements of Human Engineering." This is to be followed soon by "Problems in Human Engineering," which will give students' solutions of "perplexing situations taken from actual industry." Mr. Gow has the happy faculty of driving home plain truths by a wealth of well-told incidents, drawn largely from his own experience. Among the main topics of the present volume are: "The Value of Favorable Impressions," "Obedience, That Tie of Organization," "Common Sense," "Men, Money and Materials," and "Happiness, the By-Product." The book closes with a short autobiographical sketch entitled "So Far." Those who have been puzzled to know just what "human engineering" is will find an answer in this and the preceding volume—uncommon sense in tackling one's job and in personal relationships, whether as boss or subordinate.

Fitting Memorial

THE PUBLIC PAPERS OF FRANCIS G. NEWLANDS—Edited and Placed in Historical Setting by Arthur B. Darling, Associate Professor of History in Yale University. Two volumes. Boston and New York: Houghton Mifflin Co. Cloth; 6x9 in.; pp. 434 and 426. $10.

FEW MEMBERS of either branch of Congress have contributed as much to its work that is of interest to engineers as did Francis G. Newlands in his quarter century of service as representative and senator from Nevada. He was "father" of the reclamation service act of 1902. He worked long and arduously for legislation designed to insure the study and development of the streams of the country in such a way as to obtain their fullest possible utilization for irrigation, navigation, power and city water supply, as well as their control against floods and erosion. After ten years of arduous work and many defeats he obtained legislation in 1917 for the creation of a waterways commission. Had he not died soon afterwards, possibly the commission would have been created; but because of war and post-war conditions and perhaps other reasons the commission was never appointed, and the legislation was nullified by the federal water-power act of June, 1920, which in result if not intent was quite different in scope.

A considerable part of the two handsome volumes entitled "The Public Papers by Francis G. Newlands" is occupied with chapters on irrigation, inland waterways, floods, water-power and river regulation. Other chapters of appeal to engineers deal with forests, coal lands, conservation and politics, railroads, labor and transportation. Among still other topics are silver money, which introduced Mr. Newlands to politics and statesmanship, the interstate commerce commission and trusts.

The compilation has been well done and will serve as a fitting memorial to one of our ablest and most devoted statesmen.

Surveying Methods in Britain

PRACTICAL SURVEYING: A Text-Book for Students Preparing for Examinations or for Survey Work in the Colonies—By G. W. Usill, Assoc.M.Inst.C.E., Revised by Col. Sir Gordon Hearn, R.E. (Ret'd), Assoc.Inst.C.E. Fourth Edition, Revised. London: Crosby Lockwood & Son. Cloth; 5x7 in.; pp. 379; with four lithographic plates and 360 cuts in the text. 8/6.

ONE needs but to run through the illustrations of this surveying manual to gain recognition of the radical differences that exist between surveying methods in this country and those still in common use in England and the British colonies other than Canada—assuming, of course, that this book, now in its fourteenth edition, truly reflects current British practice. Here one finds the "cross-staff" and the "optical square," both curios kept for display to engineering students in this country, illustrated and their uses described in detail. Further, much of the descriptive matter on methods of surveying is in terms of chains and links; and the author, while noting the obvious advantages of the 100-ft. chain, states: "Pending complete revolution of our system of mensuration, I must admit my preference for Gunter's chain." The unfamiliar appearance of the theodolites, levels and other surveying instruments further serves to emphasize the differences in surveying practice here and abroad.

Obviously, the fundamentals of surveying are the same, but the use of chains and links rather than feet and tenths and the use of unfamiliar terms render the book of little value in this country except as an example of how our surveying methods, based on British practice, have diverged from their original models.

Publications Received

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

THE ADMINISTRATION OF REGULATORY INSPECTIONAL SERVICES IN AMERICAN CITIES—By Edna Trull. Paper; 7x10 in.; pp. 184; tables. $1 from Municipal Administration Service, 309 East 34th St., New York City.

CONSUMER SURVEY OF THE AMERICAN GAS INDUSTRY: Containing Data on Communities Supplied with Gas and Utility Companies Rendering Gas Service. New York: American Gas Association, 420 Lexington Ave. Stiff paper covers; 8x11 in.; pp. 566. $5.

Gives for each state list of gas companies, with location of main office, number of consumers, kind of gas sold, affiliation, if any, with a holding company or managing group; summaries by counties; list of incorporated places with more than 2,000 population without gas service; and alphabetical list of all communities supplied with gas, together with population and other information.

DEUTSCHE NORMEN FUR PORTLANDZEMENT. EISENPORTLANDZEMENT UND HOCHOFENZEMENT. Berlin: Wilhelm Ernst & Sohn. Paper; 7x10 in.; pp. 23; diagram and tables. 0.6 marks.

THE EMPIRE MUNICIPAL DIRECTORY AND YEAR BOOK, 1932-1933—Fiftieth year. London: The Sanitary Publishing Co. Ltd., Breams Bldg. E.C.4. Cloth; 7x9 in.; 326. 12/6 net.

Besides giving names and addresses of the administrative staff of cities and towns in Great Britain and other parts of the empire, this contains articles on various classes of municipal works and services and a classified buyer's guide.

ENGINEERING SEISMOLOGY: Notes on American Lectures—By Dr. Kyoji Suyehiro, Late Director, Earthquake Research Institute, Imperial University of Tokyo, Japan. Part II, Proceedings Am.Soc.C.E., May, 1932. Paper; 6x9 in.; pp. 110; 65 illustrations. $1 from American Society of Civil Engineers, 33 W. 39th St., New York City.

With the financial assistance of John R. Freeman, the late Dr. Suyehiro (died April 9, 1932) visited America in the fall of 1931 at the invitation of the American Society of Civil Engineers, to lecture on engineering seismology in some prominent American universities. Mr. Freeman contributes an introduction to the notes on the lectures.

SLUMS, LARGE-SCALE HOUSING AND DECENTRALIZATION: Reports of the Committees on Blighted Areas and Slums, Abram Garfield, Chairman; Large-Scale Operations, Alfred K. Stern,

Chairman; Business and Housing, Harry A. Wheeler, Chairman; Industrial Decentralization and Housing, Stuart W. Cramer, Chairman. Edited by John M. Gries and James Ford. Washington, D. C.: The President's Conference on Home Building and Home Ownership, Commerce Building. Cloth; 6x9 in.; pp. 245; $1.15.

ERLÄUTERUNGEN ZU DEN BESTIMMUNGEN FÜR STEINEISENDECKEN 1932—Dr. Ing. Rudolf Roll, Beratender Ingenieur VBI, Berlin-Lichterfelde. Berlin: Wilhelm Ernst & Sohn. Paper; 5x7 in.; pp. 76; illustrations. 2.3 marks.

HANDBUCH DES HOCHBAUES: Berechnung, Durchbildung und Ausführung—Von Ing. Robert Schindler. Vienna, Austria: Julius Springer. Cloth; 6x9 in.; pp. 709; tables and diagrams.

HOLZERNE BRUCKEN: Statische Berechnung und Bau der gebräuchlichsten Anordnungen—Von A. Laskus, Geheimer Regierungsrat, Berlin. Dritte neubearbeitete Auflag. Berlin: Wilhelm Ernst & Sohn. Paper; 7x10 in.; pp. 173; 311 text illustrations. 10 marks.

HOYER-KREUTER TECHNOLOGISCHES WÖRTERBUCH; Sechste vollkommen neubearbeitete Auflage—By Dr.-Ing. C. H. Alfred Schlomann, unter Förderung des Deutschen Verbandes Technisch-Wissenschaftlicher Vereine und des Vereins Deutscher Ingenieure sowie zahlreicher Industriefirmen des In-und Auslandes. Erster Band, Deutsch-Englisch-Französisch. Berlin: Julius Springer; sole agent in the United States, The Industrial Press, 148 Lafayette St., New York City. Cloth; 8x11 in.; pp. 795. Price, for the three volumes, $55; for two volumes, $37.50; for one volume, $19.50.

PUENTES DE FABRICA Y HORMIGON ARMADO—Por Don Jose Eugenio Ribera: Inspector General De Caminos, Canales y Puertos Profesor De La Asignatura En La Escuela Especial del Cuerpo. Cloth; 6x9 in.; pp. 368; many illustrations. 30.7 pesetas from the author, Pinar, 22, Madrid, Spain.

STAHLHOCHBAUTEN — Von Friedrich Bleich. Berlin: Julius Springer. Cloth; 8x11 in.; pp. 558; many tables and diagrams. 66.5 marks.

STATIQUE EXPERIMENTALE DES CONSTRUCTIONS CONTINUES: Etude Et Résolution, Au Moyen De Modèles Réduits, Des Systèmes Hyperstatiques (Méthode Générale, Simple, Applicable Aux Constructions En Béton Armé, En Métal, En Bois, Etc.)—By Paul Carot, Ingénieur des Constructions Civiles, and Christian Rieckhof, Ingénieur-Conseil. Paris, France: Constructeur De Ciment Armé. Paper; 6x9 in.; pp. 181; illustrations. 35 francs.

STRESSES IN FRAMED STRUCTURES: Part I, Design of Steel Mill Buildings—By Milo S. Ketchum, C.E., Sc.D., M.Am.Soc.C.E. Dean of the College of Engineering and Director of the Engineering Experiment Station, University of Illinois; Consulting Engineer. New York and London: McGraw-Hill Book Co. Inc. Cloth; 6x9 in.; pp. 213 line cuts; $2.50.

Part I of Professor Ketchum's well-known "Resign of Steel Mill Buildings" is here put out separately for the convenience of those who require only the elementary phase of the subject that is treated completely in the original book.

THERMISCHE UND DYNAMISCHE BEDINGUNGEN DER EISBILDUNG IN WASSERLAUFEN. Auf Norwegische Verhältnisse Angewandt (Geofysiske Publikasjoner Vol. IX. No. 1 Utgitt Av Det Norske Videnskaps-Akademi 1 Oslo) Oslo: Grondahl & Sons. Paper; 9x12 in.; pp. 100; line cuts and tables. 9.5 kr.

TRAFFIC REGULATION IN SMALL CITIES—By Dwight McCracken. Paper; 7x10 in.; pp. 25; 6 line cuts. 25c. from Municipal Administration Service, 309 East 34th St., New York City.

Letters to the Editor

Cold-Rolled Phosphor Bronze for Bridge Bearing Plates

Sir—In answer to numerous inquiries from bridge engineers for an expression as to the relative merits of phosphor bronze bridge plates machined from highly leaded castings as used in tests by the California state highway commission (*ENR*, June 25, 1931, p. 1058) and cold-rolled phosphor bronze plates, the following discussion is submitted:

According to the explanation in the above-mentioned article, a series of dry frictional tests were conducted under specific load; two phosphor-bronze pieces being placed together and moved lengthwise, under pressure, for a certain number of times. Under these conditions the composition containing a high percentage of lead was found more satisfactory than any other, as it provided easier sliding movement and the plates showed no tendency to stick or freeze together. This is entirely in keeping with the general belief that a highly leaded phosphor bronze is the best bearing metal available.

There is some question, however, as to how accurately these accelerated tests represent actual conditions under which phosphor-bronze bearing plates are required to function. In the first place there must be a certain amount of heat generated during the test which is not found in the normal movement which takes place during atmospheric changes. The element of heat in a test of this kind is detrimental to the action of cold-rolled plates, whereas in a highly leaded casting the lead acts as a lubricant. Further than this, it is well known that dry installations are exceedingly rare. Practically all bearing plates are coated with graphite or a similar substance when placed in service.

The majority of engineers prefer a bearing plate of great strength. A highly leaded phosphor-bronze plate cannot be cold rolled and therefore retains its cast structure. Castings, being of more open grain, are inclined to brittleness and quite frequently are unable to withstand the rough handling incidental to installation. With reference to cold-rolled phosphor-bronze plates, one highway official writes the following: "Our investigations have convinced us of the superiority of this material and we plan to insist on its use on all future work." Another says: ". . . we have for some years used cast plates. These require milling and are more expensive than the cold-rolled plates. In my judgment the cold-rolled plates will prove fully as satisfactory as the cast plates and will be considerably more economical." And still another writes: ". . . the department in the past has used cast phosphor bronze for bearing plates in bridge construction with unsatisfactory results in several instances, such as plates cracking during riveting and during shipment and erection. For the past year the department has been specifying rolled phosphor bronze, which has proved entirely satisfactory."

Cold-rolled phosphor-bronze plates possess high tensile strength and the desirable tight knit grain structure insured only by cold rolling, and in addition the surface is smooth and uniform, requiring no subsequent machine work before installation. Since it has become known that cold-rolled phosphor-bronze plates will meet all requirements of A.S.T.M. Specification B22-21, an increasing number of state highway commissions are including the words "cold rolled" in their specifications. This product has been used for a number of years and not a single failure has yet been reported either during installation or after a period of service. There is no great danger fo cold-rolled plates freezing or welding together to the extent that their ability to operate satisfactorily is impaired. This is confirmed by years of service on bridges where a full range of operating conditions has been experienced.

The following tabulations show the results of actual tests of cold-rolled plates manufactured to Specification B22-21, classes A and B:

Class A		Class B	
Compression Test		Compression Test	
Compression Stress	Lb. Per Sq.In.	Compression Stress	Lb. Per Sq.In.
At 0.10% set	61,500	At 0.10% set	61,500
At 0.50% set	75,600	At 0.50% set	70,250
At 1.00% set	80,700	At 1.00% set	72,500
Permanent set at 100,000 lb. per sq.in. Compression stress, 7.73%.		Permanent set at 100,000 lb. per sq.in. Compression stress, 15.95%.	
Tensile Tests		Tensile Tests	
Size tested, dia., in.	0.485	Size tested, dia., in.	0.495
Tensile strength, lb. per sq.in.	85,000	Tensile strength, lb. per sq.in.	61,600
Elongation in 2 in.	8.00%	Elongation in 2 in.	4.50%

New York, N. Y., April 27, 1932.

J. C. PETTIGREW, American Brass Co.

Taxes on Waterworks Property

Sir—The bulk of the present St. Paul water supply is pumped from the Mississippi River several miles north of Minneapolis in an adjoining county. About 1½ miles of steel pipe and nearly 7 miles of 5-ft. reinforced-concrete conduit discharge into our main lake supply north of the city. Another chain of lakes, several miles north, are also used as an emergency supply and pumped through concrete conduit and open ditch to the same lake. This emergency supply is in the same county as the river supply.

For many years this department paid the land tax on some high tillable land acquired years ago to prevent contamination. A few years ago the commissioners of this adjoining county ordered

the county auditor to list pumping stations, pipes and conduits for taxation, which we contested. It seems like stretching the law to suit a particular case. This property is of no value to anyone else, and if it is taken for taxes, no one would accept it as a gift and agree to remove it all. Ninety per cent of its cost is labor, direct or indirect. This department incurred this expense to furnish a vital physical necessity without a commercial profit. Why penalize philanthropy or an intangible thing like labor in a case of this kind? Not being a lawyer, I can't reconcile it with reason or justice. I don't believe it ever was the spirit or intent of the law. In fact it seems to be a case where the law is "more honored by the breach than by the observance."

If this kind of so-called property has no tangible value to the buyer when finally sold by the state for taxes, I cannot understand by what process of logic it can be claimed to have value for the purpose of taxation to enrich the treasury of the state or its subdivisions. To the writer it seems like a legal fiction. The county attorney thought I was introducing a "revolutionary principle" but has never pushed the case to a decision.

I wonder if any of your readers can recall a case in point? We would be glad to hear from them.

St. Paul, Minn., April 22, 1932. C. M. CROWLEY, Water Registrar.

Cement Container Questions

Sir—With the present trend toward finer grinding of cements in general and the increasing use of high-early-strength varieties, have you encountered any question as to means for better protection against premature set in shipment and storage? There seems to be a belief that these finer cements need a higher degree of insulation than was formerly necessary, and I have wondered if your publication, or any other that you know of, has had occasion to make a study of this. Such a study might include the question of damage that moisture may cause not only to the quick-setting properties of the material but also to the ultimate strength of the concrete.

In any question of packages, of course, an investigation does well to consider economics as well as technical requirements. It would seem advisable to determine what, if any, additional expense in container costs is justified by the savings resulting from various degrees of protection against moisture. The question of whether finer grinding of cement increases the loss by sifting through the mesh of fabric bags also might be worthy of attention.

In matters of this kind it has been my experience that it is not safe to rely upon laboratory tests alone or to form conclusions solely on the reports received from the field. The results from both sources often need to be checked against each other. Anyway, isn't the problem of sufficient importance to warrant the gathering of all available data?

New York City, June 10, 1932. INQUIRER.

EDITOR'S NOTE—We understand that a study of the effect of moisture on cement packed in cloth and paper bags some years ago showed more moisture effect with cloth sacks. This study related to standard cement only. Loss by sifting was not investigated. Statements of experience by users of cement would be helpful.

Another Cement Plant Projected

Sir—In view of the overdevelopment of cement-producing capacity in the United States and the distressing conditions in the industry in recent years, it is interesting to note a recent circular offering for sale securities in a new cement company that proposes to build a plant in the Lehigh Valley region of eastern Pennsylvania.

Some of the statements in the circular are so contrary to the general understanding of conditions in the industry that a study has been made to develop the facts. The circular says: "Cement is one of the fastest growing and most profitable industries in the United States."

The facts are, according to U. S. government figures, that consumption has steadily declined from the peak figure in 1928 of 178,000,000 bbl. to 126,000,000 bbl. in 1931, with estimates of 1932 consumption as low as 85,000,000 bbl.

The circular of this new cement company estimates cement consumption in 1935 at 200,000,000 bbl. Careful investigation confirms the belief that this is a gross exaggeration.

The manufacturing capacity now existing in the United States can produce 260,000,000 bbl. annually. Consumption in 1931 of 126,000,000 bbl. was less than half of capacity. The estimated consumption of 85,000,000 bbl. in 1932 is less than one-third of present producing capacity.

In the Lehigh Valley-New York State section the present producing capacity is 71,000,000 bbl. Consumption in 1931 of about 39,000,000 bbl. is only a little more than one-half of existing capacity. During the first four months of 1932 all plants in this region showed a shrinkage in shipments of one-third from those of the same period last year. Applying this reduction to shipments for the entire year of 1932 would make the 1932 total shipments about 26,000,000 bbl., or only a little more than one-third of capacity. In other words, existing capacity in the region where this proposed new plant is to be built is now nearly three times consumption demand. Does this justify building another plant or selling stock in such a plant to the general public, unacquainted with the facts?

An examination of the financial statements for 1931 of five of the leading domestic producers whose figures are available shows that they sustained a combined loss of over 12c. per barrel. These companies are recognized to be low-cost producers. The income statements for 1931 for five other cement companies, all of whose plants are located in the Lehigh Valley-New York State region where this new plant is proposed to be built, show a loss of 22c. per barrel.

Cement prices have been steadily declining for a number of years and are now at the lowest level in more than fifteen years.

It would appear that prospective investors should be acquainted with these facts before putting money into securities in a new venture in an overbuilt industry that is showing such large losses. Those desiring to invest in the cement business can do so by purchasing securities of many of the leading established cement companies whose securities are carried on the New York Stock Exchange and other exchanges in the country and are now selling at but a small fraction of their true book value. INVESTOR.

New York City, June 13, 1932.

Relief and Construction

Sir—Reading the articles that have appeared recently in *Engineering News-Record* and other periodicals relating to the public-works program submitted to President Hoover, it seems almost incredible that the President, a member of the American Society of Civil Engineers for the past 22 years, should have given to the communication coming from representatives of a society—his own—numbering over 15,000 members so scant attention as to misconstrue it to the extent he did.

Universal as is the sympathy in these times of distress with needy women, children and those incapacitated for work, with the present duty of aiding them with money, food and other necessities of life, there are the large numbers of able-bodied who are unemployed and doing nothing. Scarcely a county or municipality but has from a few to many thousands of the latter that are being given money or orders for food and necessities. For this purpose taxes are raised. It would be far better to give the able-bodied unemployed nothing unless they earned it than to encourage them in idleness. Not a few take the position that they will always be cared for. Getting out of the habit of working is bad for one's morale.

The question arises, can work be found for all? I believe the answer is in the affirmative. President Hoover's limitation of federal aid to "income-producing works" is sound only if such works are suffiicently numerous, large.

well distributed over the states and can be started with little delay. The long time necessary to start construction on federal and state works cannot aid unemployment greatly this year, and the small amount that would be saved to counties and muncipalities by federal aid in bond issues will not forward local constructions to any great extent.

Therefore, non-income-producing works appear to be a necessity. These will, of course, increase bonded indebtedness, but if we believe that the present depression will not be of further long duration, the taxpayers should prefer the issuance of bonds for construction purposes to raising taxes to support the idle, inasmuch as the expenditures would not be wholly wasted if incurred for the construction of highways, grade-crossing eliminations, some types of buildings and other non-income-producing works, which, while not returning a money income directly, will serve a useful purpose at some future time.

But the needy able-bodied unemployed person, if kept busy and paid in accordance with the manpower he exerts, will be kept physically fit, out of idleness and mischief; and the ultimate cost, even if his work be entirely useless, will not be greater than his "dole." There is no farmer who would pay, board and lodge his hired help and let him loaf so long as something on the farm needed or might have attention—and the farmer would be very prolific in thinking of something. The potatoes in the cellar might be sprouted twice as often as is customary, or old Dobbin curried and brushed to "shine like a nigger's heel."

Public- and private-works construction will not alone bring the country back to normal times, but it can be a powerful factor to that end. In public work petty politics and its co-partner, favoritism, must be cut out. No sympathy should attach to nor should aid be given the able-bodied unemployed who will not work and make his labor worthy of his hire, and he should be made to understand that the public will not brook extravagance in his living, but that in these times he must do his part in the restoration of business prosperity.

CHARLES C. HOPKINS,
Consulting Engineer.

Rochester, N. Y.,
June 7, 1932.

The New M.K.T. Lift Bridge

Sir—We note with a great deal of interest the article descriptive of the new M.K.T. Railway bridge over the Missouri River at Boonville, Mo., published on p. 255 of your May 26 issue. The article seems to be accurate in every respect except that you state that the superstructure was fabricated and erected by the American Bridge Co. Ordinarily we do not take exception to statements of this character, but in this instance, due to the magnitude of the project and the wide-spread publicity given by your magazine, we feel that recognition should be given to the fact that the Kansas City Bridge Co. erected this steel under a subcontract from the American Bridge Co., and installed all machinery except the electrical portion. The erection of steel was started on Aug. 1, 1931, and the bridge was opened to traffic Feb. 1, 1932. Therefore only five months were required for erection of this project, which is an accomplishment of which we are very proud.

A. D. HARVEY,
Assistant Chief Engineer,
Kansas City Bridge Co.

Kansas City, Mo.,
June 2, 1932.

Public Borrowing Now Would Retard Recovery

Sir—President Hoover deserves the commendation of the engineering profession as well as that of the public at large for his firm and decisive action on the proposal for a huge public-works bond issue. In a statement to the press in January he is quoted as saying, "We cannot squander ourselves into prosperity." A terse statement and straight to the point. We did squander ourselves into this depression. We must work our way out of it.

Many and varied theories have been advanced as to the cause and remedy for our present situation. The cause of this depression is the same as that of all depressions that we have suffered in the past—namely, overinflation. The same condition has existed after every war, and the same result has followed. War has not been the only cause of inflations, but war has been followed very consistently by inflation. The greater the inflation the greater the depression that followed. Depressions are very persistent in running through the same periods. When prices have reached the irreducible minimum, when unemployment has become acute, when retrenchment has been forced upon the country, when liquidation is complete, then we are ready for recovery.

Technological improvements, new inventions, discoveries of new resources, a return to work and thrift have been important factors in leading the way out of previous depressions, coupled with a return of confidence and increase of credit. The Federal Reserve Bank and the Reconstruction Finance Corp. are endeavoring to restore confidence and increase the supply of credit, both of which are absolutely essential to recovery. A huge program of public borrowing at this time would retard recovery rather than stimulate it by absorbing the credit that is needed for private business.

Our banking and credit system needs revision to prevent excessive inflation in the future and the inevitable depressions that follow such a condition. The brakes should be applied in times of prosperity to prevent flooding the country with so-called securities, which are based upon inflated and not upon real values. We see now that values are not made by piling corporation on corporation, and with each manipulation pouring more water into the mixture and selling that water to a gullible public. On the other hand, our banking and credit system should be in a position to expand during hard times and thus assist in carrying us through the pinch.

WALTER H. WHEELER.

Minneapolis, Minn.,
June 3, 1932.

Prefers Dole and Low Wages

Sir—The editorial in *Engineering News-Record* of May 19, 1932, entitled "Construction or Dole" is interesting as an example of the effort being made by many to effect the ending of the depression by psychic means. The author overlooks the ever-present wage factor. How can private enterprise be brought to enter the construction field and pay the wages demanded by the building trades? Certainly everyone realizes that buildings built during the boom period must be depreciated from 50 to 60 per cent. The war wages could not go on forever.

The editorial applauds the idea of public works, doubtless with the thought that what the public expense amounts to is nobody's business, when in fact it is everybody's business. The argument is made that it is better to pay money out for wages than for a dole. It is a question. Who has not heard of the successful man who has attempted to employ his poor relations in his growing business but has finally ended by pensioning them off so that they would not interfere with the progress of abler men?

Living costs are down to the lowest point in half a century, and yet a carpenter, a plasterer or a hod-carrier expects to be paid three or four times what he received in 1913. States and even the national government have specified, in awarding construction contracts, that the contractor shall pay high wages, thus taking the money out of the pockets of one person to pay another. A few, but a mighty few, municipalities have decreased wages. Some have decreased 10 per cent. Cannot it be realized that eventually we will have to come down to an equitable wage for all classes? Municipalities can keep up a high wage until the taxpayer fails. Railroad unions, through political chicanery, can maintain artificial standards of wages. Manufacturers, through the fiction of the high tariff, have kept up high wages, and agriculture has of course been controlled by world prices.

N. F. HOPKINS.

Pittsburgh, Pa.,
May 21, 1932.

NEWS OF THE WEEK

City Operation of New York Subway Is Authorized

MUNICIPAL OPERATION of the new 8th Ave. Subway system in New York was voted by the Board of Estimate, sitting as a committee of the whole, on June 14. Final ratification of its own action at a special meeting to be held June 17 is all that is now required before the plan for municipal operation can be put into effect.

Twice during the past few months the Board of Transportation has called for bids to operate the subway but no satisfactory offer has been received.

Under the plans submitted to the Board of Estimate the operating organization will be headed by John R. Slattery, the present deputy chief engineer. Col. Slattery is a former army officer who resigned his commission about seven years ago to become assistant to Robert Ridgway, the chief engineer. The Board of Transportation has been building up the nucleus of an operating organization for some months past in case it received a call such as the present one to take over operation. No date has been set for the start.

Gas in Liberty Tunnels May Bring About Traffic Changes

Because of undesirable concentration of carbon monoxide gas in the Liberty tunnels in Pittsburgh, a committee recently appointed to study the situation has reported that changes in the traffic operating methods in the tunnels are desirable in order to reduce the hazard from poisoning which now exists. Barring of pedestrians and of horse-drawn vehicles during peak-load hours is recommended and also a *minimum* speed of 25 miles per hour. Traffic counts for a five minute period run as high as 284 vehicles, or at the rate of 3,400 per hour. Congestion now occurs due to slow-moving vehicles in the tunnel.

The report proposes that the ventilating system be studied and expanded if necessary, so that it can be operated according to the demands upon it. Carbon-monoxide indicators, such as are used in the Holland tunnels at New York, are recommended for determining the rate at which the ventilating equipment is operated.

Highway Bond Issue Proposed for Relief in Pennsylvania

Among the proposals now being considered for a special session of the Pennsylvania State legislature is one made by Governor Pinchot for a constitutional amendment to permit a bond issue of $50,000,000 for highway construction. Governor Pinchot would repay the bond issue out of gasoline tax receipts.

Tolls on High Viaduct Over New Jersey Meadows Opposed

Tolls cannot be collected on the viaduct now being built by the New Jersey State Highway Commission across the New Jersey Meadows, according to a finding of the state attorney-general. The viaduct, three miles long and crossing the Hackensack and Passaic rivers at a height of 135 ft., is costing the state $20,000,000. It was proposed to the commission that it might charge tolls for the use of the viaduct as a means of revenue during the present emergency. The attorney-general ruled that the charging of tolls would be contrary to the highway policy of the state legislature, that the bond issues used to finance the highway do not provide for the collection of tolls, also that federal-aid funds cannot be used except for free highways.

Boston Subway Extension Approved by Legislature

An appropriation of $8,500,000 with which to extend the Boston subway from Market St. to Gainsboro St. was approved during the closing hours of the Massachusetts legislature and has been approved by the governor. The subway extension is a continuation of the Huntington Ave. line in the Back Bay district.

Michigan to Aid Municipalities in Refinancing Loans

DANGER of default on $50,000,000 of bonds issued by the local governments in Michigan which will mature during the next 12 months was avoided by the organization on May 21 of a Public Debt Commission under the authorization of the state legislature. The formation of the new commission is a preliminary in a refinancing program that will permit the renewal of obligations totaling $300,000,000 or more during the next five years.

The outstanding debt of the local governments in the state is now $814,148,000. It is estimated that $71,800,000 will become due within the next 12 months. The plan at present is to refund $50,000,000 and retire the balance. Before any of the debt may be refinanced the local government involved must apply to the Public Debt Commission and submit to the state a detailed statement analyzing its financial condition.

The bonds represented were sold during prosperous years but are now beginning to mature at a time when the governments are short of funds, principally because of tax delinquencies and the high cost of welfare work.

Speeding of Needed Public Construction By Local Units Urged on Congress

National Committee for Trade Recovery starts active work to stimulate construction of needed public works by states, counties and municipalities throughout the country

SPEEDING up of public construction by passage of the Wagner bill or some similar measure was urged upon Congress by representatives of many organizations in the building and general construction industry at a meeting held in New York on June 3. The meeting was held under the auspices of the recently organized National Committee for Trade Recovery. Federal aid to state, county, and municipal construction operations was stated by Willard T. Chevalier to be the best means of keeping up the general average of construction as an aid to business recovery and to reduce unemployment.

The National Committee for Trade Recovery was organized recently for the purpose of stimulating the immediate construction of necessary and productive public works in every part of the country. The committee's activities are sponsored by the Construction League of the United States. Robert D. Kohn, president of the league is chairman of the committee and J. P. H. Perry is vice-chairman. Chairmen of state committees have already been named.

The work of the national committee and of the state committees is two-fold, first to secure action by Congress in providing federal credit to finance state and local public work, and second to carry on an educational compaign to convince public officials and disinterested citizens that trade recovery can be stimulated through a large program of public construction.

The Construction League, sponsor of the committee's work is made up of the following organizations: American Institute of Architects, American Institute of Steel Construction, American Society of Civil Engineers, Associated General Contractors, Contracting Plasterers International Assn., Electrical Guild of North America, International Cut Stone Contractors & Quarrymen's Assn., International Society Master Painters & Decorators, National Association Marble Dealers, National Association of Master Plumbers, National Committee of Building Congresses, Producers' Council, Roofing & Sheet Metal Industries, American Road Builders Association, Common Brick Manufacturers' Association.

Headquarters of the National Committee for Trade Recovery have been established in the McGraw-Hill Building, 330 West 42nd St., New York.

Federal Financing of New Tube at New York Proposed

Formulation of plans for federal financing of the projected vehicle tunnel under the Hudson River at 38th St., New York, was authorized by the Port of New York Authority at a recent meeting. The tunnel is one of the "self-liquidating" projects listed among those considered by Congress for financial aid as a relief measure if funds are to be provided for relief work.

Stopping Work on Pine Canyon Dam at Pasadena Urged

Work on the construction of the $10,000,000 Pine Canyon water storage project, begun last month, should be stopped, according to views expressed by F. J. Walker, former city director, and R. F. Burnham, investment broker of Pasadena. Both oppose the construction of the dam on the ground that there is no immediate need for it and hence no justification for further addition to the public debt. Mr. Walker points out further that Pasadena has no written or verbal agreement with the Metropolitan Water District of Southern California to purchase the Pine Canyon reservoir for part of its distribution system for the Colorado River water.

Hoover Dam Notes

At the Hoover Dam laboratory 27 tests of 28-day-old concrete in tunnel lining give an average compressive strength of 4,476 lb. per sq.in. At Denver elasticity tests are in progress on 6x12-in. cylinders to determine the effect of varying rates of loading in arriving at the longitudinal deformations.

* * *

Design drawings for the outlet and power penstock tunnels are being checked and revised where necessary in order that construction drawings under any of the three alternative layouts in the specifications may be ready for forwarding to the field as soon as award is made for the steel-plate pipe.

Preparation of cost estimates on the installation of the steel pipe for each alternative layout also are in progress. A preliminary draft of specifications for turbines and governors has been completed.

* * *

The progress of placing concrete lining in the diversion tunnels for the week ending June 4 is shown by the following table:

Tunnel	Tunnel Length	Section	Progress, Inlet End For Week	To Date
No. 1	4,301	Invert	...	0
		Sidewalls	...	0
No. 2	3,879	Invert	240	1,166
		Sidewalls	200	926
No. 3	3,560	Invert	82	1,146
		Sidewalls	240	864
No. 4	4,165	Invert	200	1,554
		Sidewalls	137	268
All Tunnels	15,905	Invert	522	3,866
		Sidewalls	577	2,058

* * *

The latest estimate placed the number employed on the project at 3,324 persons, divided as follows: Bureau of Reclamation 246; Six Companies 2,539; subsidiaries and subcontractors 214; other government contractors 150; employees of business enterprises in Boulder City 175.

Restrictions on Use of Highways Upheld in Ohio

THE right of the Public Utility Commission of Ohio to exclude additional motor transport from certain of the state highways has been upheld by the state Supreme Court.

The Public Utility Commission denied the application of the Motor Transportation & Truck Co. for a certificate to operate over Route 2 between Cleveland and the Michigan state line on the ground that the highway already is badly congested and that the addition of the trucks of this company would create and maintain excessive and undue hazard to the traveling public. The company appealed to the Supreme Court and the court upheld the commission's ruling. The court said, in part: "Streets and highways belong to the public and are primarily for the use of the public in the ordinary way. Their use for the purpose of gain by common carriers is special and extraordinary and subject to regulation by duly constituted authority. The commission is not authorized to exclude from the highways of the state motor transportation companies conducting interstate operations, but it may impose reasonable regulation of such traffic in so far as the regulation does not constitute a direct and material burden upon interstate commerce. A condition that such operations shall be routed over a less congested highway is not infringement upon or impairment of any rights secured by the state or federal constitution."

Loan Asked for Irrigation Project in Arizona

Application for a loan of $20,000,000 has been made to the Reconstruction Finance Corp. by the Verdi River Irrigation & Power District of Arizona in anticipation of approval by Congress of loans to "self-liquidating projects."

Irrigation of 99,500 acres of land in Paradise valley on the Verde River near Phoenix, Ariz., is proposed as well as the development of 100,000 hp. of electric energy which it is proposed to sell to amortize the loan in 30 years.

The project has been under consideration for 12 years but the district has not been able to finance the start of construction. The ultimate cost is placed at $60,000,000 or $70,000,000.

Most Beautiful Steel Bridges Chosen for 1931

The three most beautiful steel bridges opened to traffic in 1931, according to a jury appointed by the American Institute of Steel Construction, were the 1652-ft. span steel arch Bayonne bridge over the Kill van Kull at New York, in Class A; the 800-ft. span Waldo-Hancock suspension bridge over the Penobscot river at Bucksport, Maine, in Class B; and the 136-ft. deck plate-girder-rib arch over the Connecticut river at West Stewartstown, N. H., Class C. The Class A structures cost in excess of a million dollars; Class B in excess of a quarter million and under a million dollars; and Class C under a quarter million dollars. The Bayonne bridge was designed by engineers of the Port of New York Authority, O. H. Ammann, chief engineer. The Waldo-Hancock bridge was designed for the state of Maine by Robinson & Steinman, consulting engineers, New York. The West Stewartstown bridge was designed by the engineers of the New Hampshire state highway department. All three bridges were erected by the American Bridge Co. The Bayonne bridge was described in *Engineering News-Record*, Nov. 12, 1931, p. 785, and Dec. 13, 1928, p. 873, and the Waldo-Hancock bridge March 17, 1932, p. 386.

Connecticut River bridge at West Stewartstown, N. H., chosen as the most beautiful steel bridge costing less than $250,000 that was opened to traffic in 1931.

An additional bridge in each class was selected for honorable mention. These were as follows: Class A, Maumee River suspension bridge built for the city of Toledo, Ohio, by McClintic-Marshall Corp. from designs by Waddell & Hardesty, consulting engineers, New York; Class B, Croton Lake arch bridge, built by the Mount Vernon Bridge Co. from designs made under the supervision of Jay Downer, chief engineer, Westchester County (N. Y.) Park Commission; Class C, Afton overhead cantilever arch bridge at Afton, Union County, Iowa, built by the American Bridge Co., from plans by the Iowa State Highway Commission. All of the winning bridges will be decorated with a stainless steel plaque.

The jury making this fourth annual award consisted of Raymond M. Hood, architect, New York; F. O. Dufour, consulting engineer, United Engineers & Constructors Inc., Philadelphia; L. C. Dillenback, professor, school of architecture, Columbia University; C. T. Bishop, professor, Sheffield Scientific School, Yale University; and A. L. Kocher, managing editor, *Architectural Record*, New York.

Will Promote Public Works for Unemployment Relief

At a meeting of cast-iron pipe manufacturers in Chicago last week plans were made for carrying on an intensive campaign of public education concerning the value of public-works construction for unemployment relief. It is intended to carry on local work in all cities of 3,000 population or over. The principal purpose of the campaign is to bring to general public knowledge the fact that waterworks improvements will not raise taxes but on the contrary will contribute to relief of the unemployment situation.

John D. Watson Honored

John D. Watson, consulting engineer, Westminster, England, former chief engineer of the Birmingham, Tame & Rea Drainage District, was guest at a dinner given by George W. Fuller at the Engineers Club, New York, June 9. Mr. Watson is in this country for a rest following a serious illness. While here he plans to visit some of the important activated-sludge sewage disposal plants. The activated-sludge process is being used in the $30,000,000 Middlesex County drainage project for which Mr. Watson's firm is consultant. Twenty-two towns adjacent to London are included in the project which is financed in part by the national government for unemployment relief.

Railway Line Abandoned

Abandonment of 94 miles of railway line in Michigan has been authorized by the Interstate Commerce Commission. The abandoned line is part of the Detroit, Toledo & Milwaukee R.R., owned jointly by the New York Central and the Michigan Central, extending from Battle Creek to Dundee. Good highways parallel the railway line through the major part of its length and much of its traffic has been diverted to them.

Water Supply From Mississippi River For Minneapolis

IMPROVEMENTS to the water supply system of Minneapolis, Minn., retaining the Mississippi River as a source of supply, were recommended by the city's water supply commission, consisting of Prof. Frederic Bass, Adolph F. Meyer and Sven A. Norling, in a report presented on June 7. The improvements recommended will involve an expenditure of $10,220,000 and include a softening plant, an activated-carbon plant to remove disagreeable tastes and odors, a 20,000,000-gal. reservoir and additional distribution lines.

Artesian wells as a source of supply were rejected by the commission. The commission found that the high mineral content of the water to be obtained from artesian sources near Minneapolis and the high cost of pumping from the great number of wells that would be necessary would make such a source uneconomical.

Stating that the present river supply is adequate and very probably always will be, the report says that with further treatment tastes and odors can be completely eliminated. In this connection the report recommends filter extensions, the installation of a softening plant, and, if necessary, the installation of an activated-carbon plant.

The present outstanding water bonds of the city total $3,848,000. The value of the present plant and system is $20,000,000. The new bonds necessary to be issued for extensions and improvements up to 1960 are $10,220,000. Under the finance plan presented, total outstanding bonds, both existing and proposed, will not at any time exceed $6,400,000. At the end of that period the system will be valued in excess of $25,000,000 and at no time will the total bonds exceed 24 per cent of the value of the plant.

Additional assistance to the department supervisor is also recommended.

OWYHEE IRRIGATION PROJECT DAM NEARS COMPLETION

The final batch of concrete was placed in the roadway on top of the dam for the Owyhee irrigation project on May 28. There remains only the clearing up work, completion of the plug in the diversion tunnel and construction of the roadways. The accompanying photograph was taken while concrete was still being placed in the dam proper. In the right foreground is the ring-gate spillway discharging through a vertical shaft to the diversion tunnel 240 ft. below.

Contractor Not Liable for Washed-Out Bridges

The Ohio department of highways must bear the cost of reconstruction of two bridges erected by the Churchill Construction Co., which were destroyed by a flood. County Judge King has ruled that although the contract specified that the contractor must guard against ordinary acts of the elements, the flood which destroyed the bridges was not "ordinary." Witnesses testified that the flood was the most severe in from 40 to 70 years.

Delaware River Commission Approved by U. S. Senate

Establishment of the Delaware River Joint Commission to supersede the old Delaware River Bridge Joint Commission, authorized by the Pennsylvania and New Jersey legislatures last year, was approved by the U. S. Senate last week. The President's approval is expected as a matter of course. Unexpected opposition to the proposal developed while it was before Congress and for a time threatened its approval.

The new commission will be charged with all interstate matters relating to port development of the Delaware River at Philadelphia and Camden. It will take over the Philadelphia-Camden bridge issuing its own bonds and repaying the two states the amount of money invested in the bridge. Among the projects to be put before the new commission is a high speed line operating over the Delaware River bridge. Provision for the construction of such a line was made when the bridge was built but its construction was postponed.

Personal Notes

H. C. McClintock, director of public service of Boulder, Colo., has been appointed city manager to succeed the late George W. Teal. Mr. McClintock will continue to head the city engineering department.

Thomas Adams, head of the Regional Plan of New York and Environs, was awarded the degree of Doctor of Engineering by New York University at its commencement exercises on June 8.

Brig. General Thomas H. Jackson, who has been serving as division engineer, Lower Mississippi Valley Division, and as president of the Mississippi River Commssion for the past 2½ years, has been assigned to duty as division engineer, South Atlantic Division, Norfolk, Va., to succeed Col. Harley B. Ferguson, whose appointment as division engineer of the Lower Mississippi Valley Division was announced in our issue of May 12.

E. R. Davis, manager of construction and engineering for the Southern California Edison Co., for the past year, has been appointed assistant general manager. Mr. Davis has been associated with the Southern California Edison Co. and its predecessor companies since 1896. In 1911 he became general manager of the Pacific Light and Power Corp., continuing in that capacity until 1917 when the corporation was merged with the Edison company. Mr. Davis was appointed superintendent

of the northern division of the Edison company at the time of the merger, and became manager of construction four years later.

Obituary

ALEXANDER FRASER, chief engineer, Department of Roads, Province of Quebec, died suddenly at Montreal on June 12.

L. A. RUSSELL, for the past eleven years an engineer in the shovel, crane and dragline excavator department of the Koehring Co., died at Milwaukee, Wis., June 4.

R. D. MAHAFFEY, vice-president and treasurer of The American Well Works, died at his home at Aurora, Ill., on June 3, at the age of 65 years. Mr. Mahaffey had been identified with the American Well Works and with the pump industry for a period of 43 years.

JAMES SHEAHAN, general superintendent of the Memphis Water Department, died suddenly at his home there on June 9. Mr. Sheahan was 64 years old at the time of his death. He joined the water department in 1911 and eight years ago was made general superintendent. Recently the new $2,000,000 pumping station was named after him in recognition of his service to the city.

A. J. HALL, superintendent of the water department of Appleton, Wis., up until the time of his resignation last March died at his home there on June 3. He was in his 37th year and had been in ill health for some time. Mr. Hall as a bacteriologist has been active in affairs of the Wisconsin section of the American Water Works Association.

SOCIETY CALENDAR

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, June 20-24.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS, annual meeting, Ohio State University, Columbus, Ohio, June 20-23, 1932.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Yellowstone National Park, July 6-9.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, 40th annual meeting, Oregon State College, Corvallis, June 29-July 1.

NATIONAL SAFETY COUNCIL will hold its annual safety congress Oct. 3-7 in Washington, D. C.

PENNSYLVANIA WATERWORKS OPERATORS ASSOCIATION will hold its fifth annual conference at State College, Pa., June 20-24.

SOUTH CAROLINA SOCIETY OF ENGINEERS will hold its summer meeting on July 4 at the lodge of Arthur Wellwood, a member of the society, on Lake Murray, near Columbia, S. C. Lake Murray is the reservoir formed behind the recently-constructed Saluda Dam.

NEW YORK STATE, CITY, AND VILLAGE ENGINEERS ASSOCIATION at its meeting held in Buffalo on June 8, elected Joseph B. Shaw of Utica as president, Carl L. Oelkers vice-president, and Joseph P. Tehan secretary-treasurer. George C. Diehl, consulting engineer of Buffalo, spoke to the association on municipal problems.

SOUTHERN ILLINOIS WATER PURIFICATION CONFERENCE was organized May 27 at Carbondale with C. S. Gill, Carbondale, as chairman. Attendance was confined largely to filter plant operators, many of whom never before had had an opportunity to attend such a meeting. Discussion centered on coagulation, copper sulphate treatment of reservoirs, taste and odor elimination, chlorination, water softening and manganese troubles. The meeting was sponsored by H. F. Ferguson, chief engineer, state Department of Health, and John R. Baylis, chairman Illinois Section, American Water Works Association. It is planned to hold monthly meetings, rotating from city to city as is done by the West Shore (of Lake Michigan) Water Producers Association so that eventually all plants will have been inspected.

Engineering Contracts and Capital

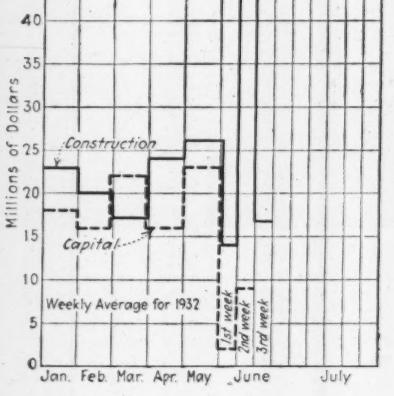
Contract awards for the past week total $17,186,000, a considerable drop from the previous week's total of over $43,000,000. New capital for the week amounted to only $7,000,000, all of which was public bond sales, no private capital issues being reported.

New York Wage Dispute—The strike of building trades in New York City, in effect since May 2, is still far from settlement. Elevator workers are reported to have been granted their demands for $11.20 per day. It was a secret agreement with this trade made after all trades had virtually accepted a 25 per cent reduction that started the strike. Bricklayers are now holding out for $13.20 per day unconditionally, having previously been granted this wage temporarily pending arbitration. Employers are offering them $13.09 unconditionally. Three major building projects are being delayed because of the strike, the Port Authority's inland freight terminal, the parcel post building and the entire Rockefeller Center program.

Cement Prices Change—Early in the month the following changes were reported in cement prices at the mill, without sacks: Iola, Kan., Ada, Okla., and Superior, Neb., advance from $1.10 to $1.35; New Jersey mills, from $1.01 to $1.11; Buffington, Ind., and La Salle, Ill., decline from $1.10 to $0.85.

Canadian Construction—Total contracts awarded in Canada during May amount to $14,186,000, more than half of which was in the province of Quebec, according to MacLean building reports. This compares with a total of $10,107,900 reported for April throughout the entire dominion.

Steel Orders Down—Bookings at the end of May of the United States Steel Corp. were 2,177,162 tons, the lowest on record. The corporation operated at 20 per cent capacity during the month. Reports from the entire steel industry for May indicate operations at 20.11 per cent of capacity.



Wide Range in Bidding—An unusually wide range in bidding was revealed with the opening on June 10 of bids for the foundation caissons for the new Albany postoffice. Fifteen bids were submitted, the low being $22,420 and the high $124,375. There was a spread of over $45,000 between the second and third high bids.

ENR Cost and Volume Index

Cost		Volume	
June, 1932	**152.20**	**May, 1932**	**149**
May, 1932	152.78	April, 1932	135
June, 1931	187.23	May, 1931	251
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.85	1930 (Average)	260
1913 Average	100.00		

Contracts and Capital

CONSTRUCTION
(Thousands of Dollars)

	Weekly Average June 1931	Weekly Average June 1932	Week June 16, 1932
Federal government	$5,039	$8,304	$2,588
State and municipal	26,395	10,172	9,274
Total public	31,434	18,476	11,862
Total private	17,647	5,560	5,324
Week's total	$49,081	$24,136	$17,186

Cumulative: Jan. 1 to date:

1931 construction	$1,349,354
1932 construction	530,030

Decrease, 61 per cent.

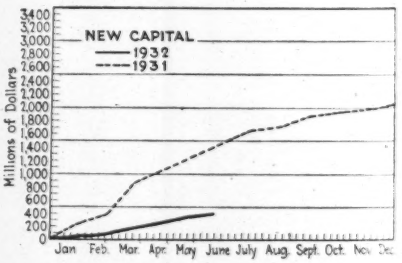
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

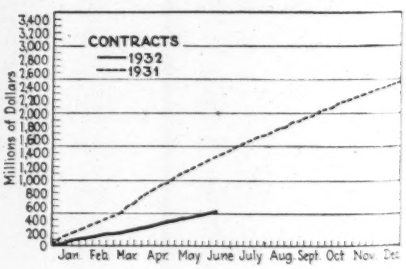
	Weekly Average June, 1931	Weekly Average June, 1932	Week June 11, 1932
Public	$23,750	$4,500	$7,000
Private	18,750	.....	.....
Week's total	$42,500	$4,500	$7,000

Cumulative, Jan. 1 to date:

1931 new capital	$1,397,000
1932 new capital	364,000

Decrease, 74 per cent.

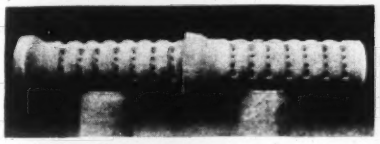




Construction Equipment and Materials

Concrete Pipe With Seepage Holes for Drainage Work

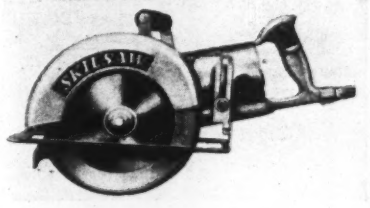
A new machine-made concrete pipe for underdrains is announced by the Union Concrete Pipe Co., Huntington, W. Va. The pipe is provided with seepage holes located in valley-like depressions. It is designed for use in draining roads, side ditches, bridge abutments, basement walls, airport fields, tennis courts and swampy grounds. The maker claims that it has ample strength and durability and that the smooth inside surface insures a high carrying capacity.



Concrete underdrain pipe.

Compact Electric Hand Saw

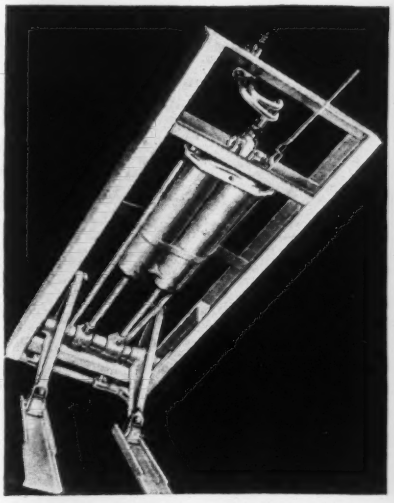
A new electric hand saw, featuring compact design, is offered for sale by Skilsaw, Inc., Chicago, Ill. The new saw is 20 in. long overall, carrying a 9-in. saw blade. It is powered with a ¾-hp. Universal motor. It has a cutting capacity 3 in. deep and is equipped with a tilting base that permits beveling of 2-in. lumber at 45 deg. On the base is a metal segment with degrees marked on it. The saw blade has a free speed of 3,600 r.p.m. and is protected by a positive automatic spring-operated telescopic guard rotating on roller bearings. The frame is constructed of die-cast aluminum.



Aluminum-frame hand saw.

New Hydraulic Body Hoist

A new hydraulic body hoist is being introduced by Fitz Gibbon & Crisp, Inc., Trenton, N. J. The new hoist has a high angle lift and quick action. The maker claims that an abundance of power is provided without subjecting either chassis or hoist to undue strain and that the load is evenly distributed over a large chassis area. It is built in two single-cylinder and two twin-cylinder models. All models are complete units, including cylinders, pump, lifting arms, hinges, pump-drive, power take-off with control, clamps and wood sills. Mounting requires no drilling of holes or other fitting, the hoist being clamped to the chassis.



Quick-action hoist with high-angle lift.

Business Notes

GRAVER TANK & MANUFACTURING CORP., East Chicago, Ind., may now make, use and sell water-softening apparatus comprising a casing, a filter bed consisting of a layer of sand or quartz and a layer of zeolites or hydrated alumino silicates disposed on the layer of sand or quartz, means for permitting the passage of water through the casing, means for cutting off the supply of water on the exhaustion of the zeolites, means for passing through the casing a solution of salt capable of regenerating the zeolites, and means for draining the salt solution out of the casing, according to an opinion of the U. S. supreme court delivered Nov. 23, 1931, in the Permutit Co. vs. Graver Corp., in which the court declared that claims 1 and 5 of the Gans patent 1,195,923 are invalid.

HERCULES POWDER CO., Wilmington, Del., announces the appointment of George M. Norman as manager of the development department of the company. Mr. Norman, who is a director of the company, has been head of the technical department, the divisions of which will now function separately. H. E. Kaiser will supervise research and experiment, and G. E. Ramer will supervise engineering activities.

BLAW-KNOX CO., Pittsburgh, has acquired exclusive manufacturing and sales rights of the Wiley concrete bucket, formerly manufactured and sold by the Dayton Whirley Co., Dayton, Ohio. This product will now be known as the Blaw-Knox concrete bucket. These buckets are made for derrick or cableway operation, but can also be used as floor hoppers for loading buggies, wheelbarrows or discharging into chutes. They are made in three standard sizes, 18, 33 and 63 cu.ft. capacity, and larger buckets can be made to order.

CLYDE IRON WORKS, Duluth, Minn., has acquired the business of the Dayton Whirley Co., Dayton, Ohio, and will manufacture the Wiley whirley cranes at its Duluth plant under the name of the Clyde Wiley whirleys. These machines are of the full-circle revolving type powered by steam, gasoline or electric motors.

DARDELET THREADLOCK CORP., 120 Broadway, New York, has granted licenses for the manufacture and sale of bolts, nuts and screws threaded with the Dardelet self-locking thread to Reed & Prince Mfg. Co., Worcester, Mass., and the Western Screw Mfg. Co., Chicago.

New Publications

Flow of Water Through Welded Steel Pipe—Charts and tables of the flow of water through Armco spiral welded pipe are given in Armco Engineering Bulletin Vol. I, No. 5, issued by the American Rolling Mill Co., Middletown, Ohio. Hydraulic data given include a special formula for the flow of water through spiral welded pipe, relative capacities of 12-in. pipe of various materials, loss of head in spiral welded pipe for various length lines of pipe from 6 to 30 in. in diameter.

Gas Engines—Worthington Pump & Machinery Corp., Harrison, N. J., describes its line of vertical four-cylinder gas engines, ranging from 60 to 180 hp. in size, in bulletin S-550-S1.

Portable Air Compressors — Bulletin W-850-B5, issued by Worthington Pump & Machinery Corp., Harrison, N. J., covers portable air compressors, showing mechanical features and mountings on trailer, truck, tractor, railroad car, mine car and wood skids.

Testing Machines—Bulletin 28 issued by the Baldwin-Southwark Corp., Philadelphia, describes the full line of Southwark-Emery testing machines. Various types of testing machines, both large and small, are fully described, as are also testing machinery accessories, such as strain gages and recorders.

New Equipment in Brief

Welding Rods—Under the trade name of RegOrod, the Bastian-Blessing Co. is introducing a new line of welding rods and electrodes. The line includes every popular type of rod such as high-speed and high-test materials. It will be sold through the existing organization of Rego distributors. It is stated that scientific research and careful field tests have been made in the development of this line of rods.

High-Speed Truck Mixer—A higher-speed truck mixer is offered by the Jaeger Manufacturing Co., Columbus, Ohio, in 1- and 1½-cu.yd. units mounted on a 1932-model Ford chassis. The 1-yd. unit is furnished for use with the 132-in. wheelbase chassis and is driven direct from the truck engine. The 1½-yd. unit is furnished with separate engine drive for the 157-in. wheelbase chassis. It is claimed that these new mixer units are particularly suited for commercial concrete plants, road-widening and maintenance work, aprons, bridges, conduit, sewers, and curb and gutter work.

Welding Heads—A new series of welding heads with detachable tips has been introduced by the Linde Air Products Co., New York City, for use with the Oxweld Type W-17 welding blowpipe. These will supplement the one-piece heads for this blowpipe, so that the user will have a choice of two types of welding heads. The new heads were developed particularly for pipe-line welding and for production operations. One of the features of the new design is the male thread on the tip, which screws into the stem. It is claimed that removal of the welding tip is thereby greatly facilitated.

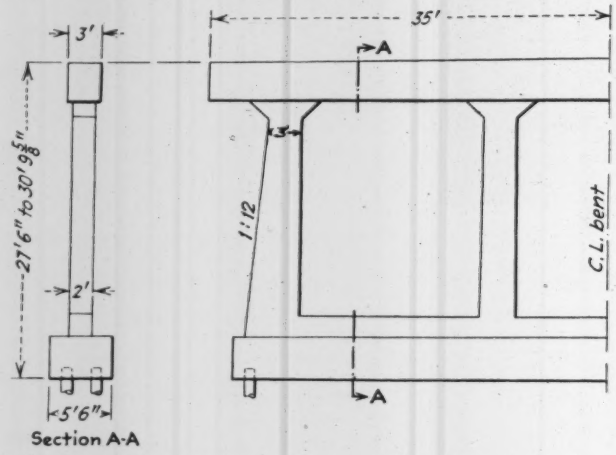
Caterpillar Power Mower—A new power mower suitable for shoulder maintenance and designed to operate with their Fifteen or Twenty tractors has been announced by the Caterpillar Tractor Co., Peoria, Ill. The new mower has a width of 7 ft. Numerous features have been incorporated in the design of the new machine, making toward improved safety and dependability of operation.

Current Construction Unit Prices

Concrete Highway Bridge at Michigan City, Ind.

A REINFORCED-CONCRETE highway bridge 405½ ft. long by 44 ft. wide is being erected for the Indiana state highway commission over the Michigan Central R.R. near Michigan City. There are nine spans, as follows: on square bents, two 40-ft.; on skew bents, two 41½-ft., one 47⅞-ft., one 43¼-ft., one 43⅜-ft.; on square bents, two 40-ft. Minimum vertical clearance is 21 ft.

Contract was awarded in March, 1932, to the Edward F. Smith Co., Indianapolis, for $92,579. Fifteen bids were received ranging to $120,036 and averaging $104,878. Engineer's estimate was $146,419. Unit prices are given of the lowest two bidders: (A) E. F. Smith; (B) Hecker-Moon Co., Cleveland, $93,543. W. J. Titus is chief engineer of the commission; Fred Kellam is assistant chief engineer.



Half elevation, both square and skew bents

			A	B
1,105.5	cu.yd.	class D concrete	$13.50	$12.00
1,119.4	cu.yd.	class E concrete	13.00	11.00
811	lin.ft.	handrail	2.50	2.50
605	cu.yd.	wet excav.	2.50	2.00
370	cu.yd.	dry excav.	1.00	0.40
40	cu.yd.	class A excav.	1.00	2.00
93,832	cu.yd.	special borrow	0.21	0.24
14,000	lin.ft.	timber piles driven (treated)	0.30	0.25
14,000	lin.ft.	timber piles furnished (treated)	0.38	0.50
424,803	lb.	Reinf. steel	0.03	0.03
8,100	sq.yd.	concrete pave.	1.40	1.60
6,233	lb.	reinf. steel for pave.	0.03	0.03
6,563	cu.yd.	peat excav.	0.10	0.12
125	lin.ft.	8-inch corrugated metal pipe	0.80	0.90
90	lin.ft.	18-inch corrugated metal pipe	1.50	1.70
3,650	lin.ft.	guard rail	0.35	0.30
12		right of way markers	3.00	10.00
1,823	lin.ft.	finishing shoulders and ditches	0.20	0.10
80	lin.ft.	1-inch bit. exp. joints	0.30	0.30
80	lin.ft.	3-inch bit. expan. joints	0.60	0.60
17,100	sq.yd.	top soil for shoulders and side slopes	0.15	0.12
4,500	cu.yd.	special excav.	0.10	0.225

East and West Storm Sewers in Salt Lake City

CONSTRUCTION started March 25, 1932, on the west section of two sections of main sewers for Salt Lake City, on which bids were received Feb. 24. Both sections were awarded to Ryberg Bros., city, for $235,850. The west section is rectangular monolithic except for 60-in. reinforced-concrete pipe through the congested section of the city and 800 ft. of 72-in. pipe under railroad yards. The east section consists of 24- to 45-in. lock-joint pipe and smaller sizes of vitrified pipe. Completion is expected by September. Depths are 6 to 14 ft.

The west section of the main storm sewer extends from Second East and Fourth South Sts. to Jordan River and Sixth South St. Bids were asked on (1) 5x6¼ ft. rectangular reinforced-concrete monolithic conduit, accepted, and on two alternates: (2) 75-in. reinforced-concrete, and (3) 75-in. circular reinforced-concrete monolithic conduit. The successful contractor's bids were respectively: (1) $7.47; (2) $10.29; (3) $11.

The East Side storm sewer extends from the University of Utah to a connection with the west section at Fourth South and Second East Sts. The principal items consist of 22,821 ft. 24- to 45-in. reinforced-concrete pipe at $1.89 to $4.15 in place, totaling $59,905.

The principal unit prices of the lowest two bidders are given on each section: East—(A) American Concrete & Steel Pipe Co., $117,692; (B) Ryberg Bros., $117,959, contract. West section—(A) American Concrete & Steel Pipe Co., $115,702, using reinforced-concrete pipe; (B) Ryberg Bros., $117,871, using rectangular. W. D. Beers is city engineer.

EAST SECTION

	A	B
Excav. and backfill, cu.yd., 17,740	$0.70	$0.98
Furnish and lay reinf. conc. pipe:		
24 in., lin.ft., 6,400	1.90	1.89
27 in., lin.ft., 1,600	2.20	2.06
30 in., lin.ft., 5,318	2.56	2.48
33 in., lin.ft., 2,063	2.89	3.00
36 in., lin.ft., 4,830	3.27	3.16
39 in., lin.ft., 1,016	3.63	3.38
42 in., lin.ft., 790	4.09	3.93
45 in., lin.ft., 804	4.50	4.15
Furnish and lay conc. pipe:		
12 in., lin.ft., 596	1.20	.90
15 in., lin.ft., 460	1.60	1.29
18 in., lin.ft., 60	2.00	1.69
Alternate Furnish and lay vitrified pipe:		
12 in., lin.ft., 596	1.20	.90
15 in., lin.ft., 460	1.60	1.29
18 in., lin.ft., 60	2.00	1.69
Tear out and replace pavement, sq.yd., 9,880	2.95	3.00
Maintaining and oiling backfill until pavement is replaced, sq.yd, 9,880	11	105
Totals	$117,692	$117,959

WEST SECTION

	A	B
Excav. and backfill (for rect. sec and 60 in. pipe, cu.yd., 24,200	$0.80	$1.05
Alt.: Excav. and backfill (if pipe or circular monolithic sec. is used, cu.yd., 27,500	.65	.97
Rect. reinf. conc. monolithic conduit:		
5 ft. 0 in. x 6 ft. 3 in., lin.ft., 3,190	9.18	7.47
5 ft. 0 in. x 6 ft. 3 in. cvd., lin.ft., 88	10.20	7.75
4 ft. 7 in. x 5 ft. 9 in., lin.ft., 2,370	8.05	6.81
4 ft. 0 in., x 5 ft. 0 in., lin.ft., 1,840	6.55	6.03
4 ft. 0 in. x 5 ft. 0 in. cvd., lin.ft., 393	7.60	6.31
*4 ft. 0 in., x 4 ft. 0 in., lin.ft., 278	7.30	5.88
*Warped section, lin.ft., 75	9.50	9.80
60 in. reinf. conc. pipe (2d E to West Temple, lin.ft., 2,749	6.50	7.75
†Alt.: Rus. conc. pipe:		
75 in., lin.ft., 3,278	8.84	10.29
69 in., lin.ft., 2,370	7.75	8.66
60 in. (2d E - 2d W), lin.ft., 4,982	6.25	7.68
Alt., Circular reinf. conc. monolithic conduit:		
75 in., lin.ft., 3,278	9.45	11.00
69 in., lin.ft., 2,370	8.25	9.50
60 in. (WTem - 2dW), lin.ft., 2,233	6.70	8.50
Furnish and lay vitrified pipe:		
4 in., lin.ft., 10	.80	.28
6 in., lin.ft., 20	.90	.42
12 in., lin.ft., 240	1.20	.95
15 in , lin.ft., 85	1.60	1.48
10 in. x 24 in. waterway, lin.ft., 108	1.40	1.84
MHs complete as per plan, 33	40.00	26.65
Total using rect. sec. and 60 in. pipe	$120,911.20	$117,879.54
	III	I
Total using reinf. conc. pipe	115,702.12	135,413.34
	I	III
Total using circ. reinf. conc. mono. cond. and 60 in. pipe	120,948.80	142,773.01
	I	V
*Common to all types Preliminary estimate	$125,000.00	